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(12) **United States Patent**
**Golino**

(10) **Patent No.: US 9,380,913 B2**
(45) **Date of Patent: Jul. 5, 2016**

(54) **FOOD PROCESSING APPARATUS AND METHOD**

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(73) Assignee: **SHARKNINJA OPERATING LLC**, Newton, MA (US)

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(21) Appl. No.: **14/703,739**

(22) Filed: **May 4, 2015**

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**Related U.S. Application Data**

(63) Continuation of application No. 14/468,941, filed on Aug. 26, 2014, now Pat. No. 9,049,967.

(60) Provisional application No. 62/035,306, filed on Aug. 8, 2014.

(51) **Int. Cl.**

| | |
|---|---|
| ***B02C 25/00*** | (2006.01) |
| ***A47J 43/046*** | (2006.01) |
| ***A47J 43/07*** | (2006.01) |
| ***A47J 43/08*** | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***A47J 43/046*** (2013.01); ***A47J 43/0716*** (2013.01); ***A47J 43/0722*** (2013.01); ***A47J 43/085*** (2013.01); ***B02C 25/00*** (2013.01)

(58) **Field of Classification Search**

CPC .... B02C 25/00; A47J 43/046; A47J 43/0716; A47J 43/0722; A47J 43/085

USPC ..... 241/33–37, 282.2

See application file for complete search history.

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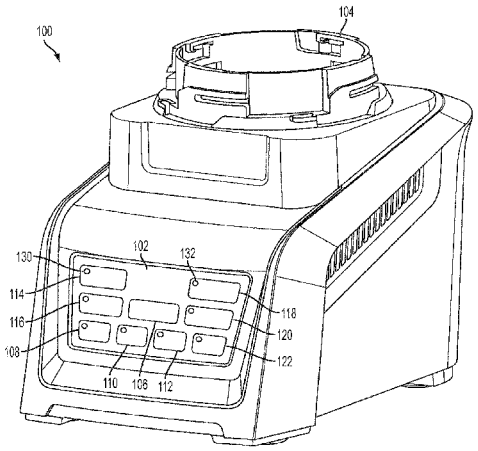
*Primary Examiner* — Faye Francis

(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

Food processing apparatus and methods for processing food are disclosed. The apparatus may include stored sequences for operating a processing tool. The stored sequences may address various challenging aspects of blending solid foods and/or ice. In some embodiments, particular sequences are implemented with specific processing tools.

**8 Claims, 26 Drawing Sheets**



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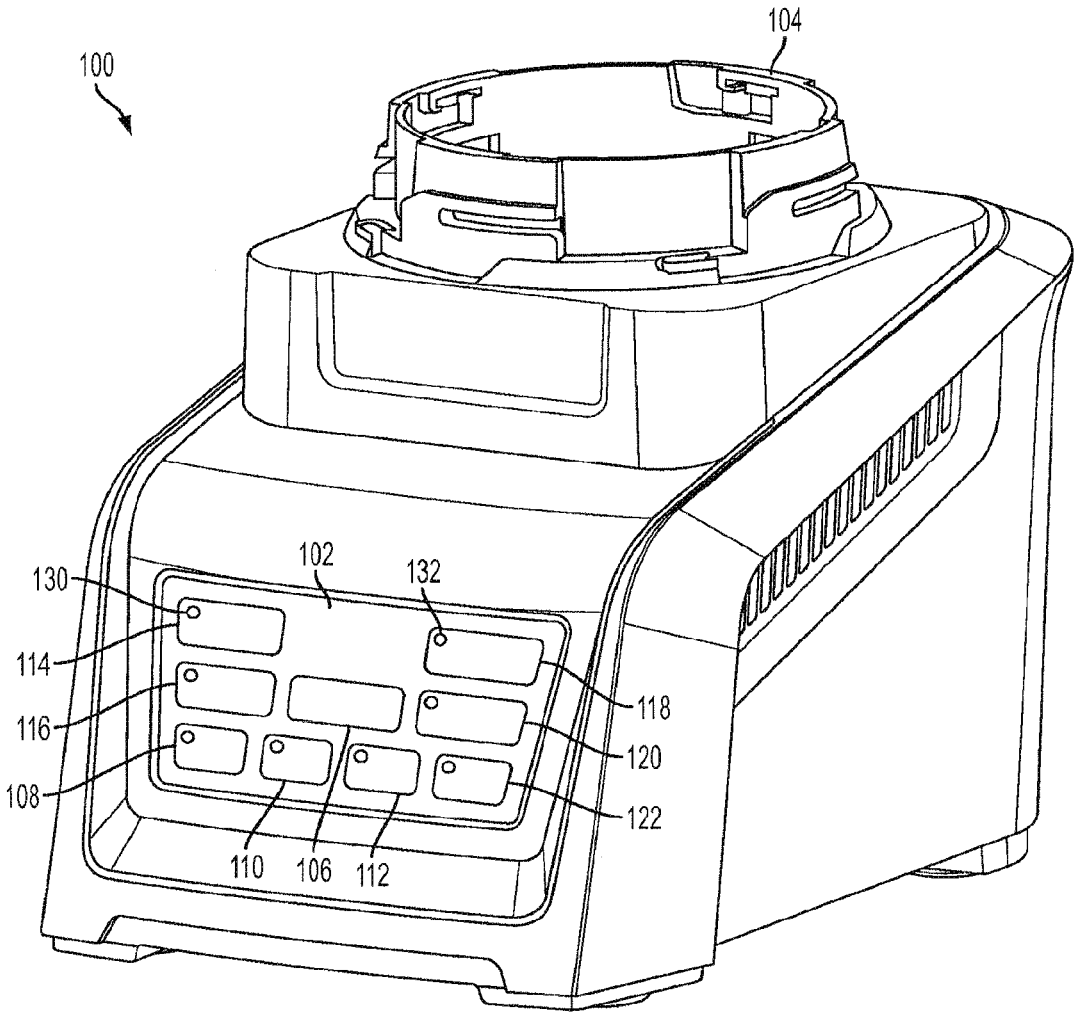



FIG. 1

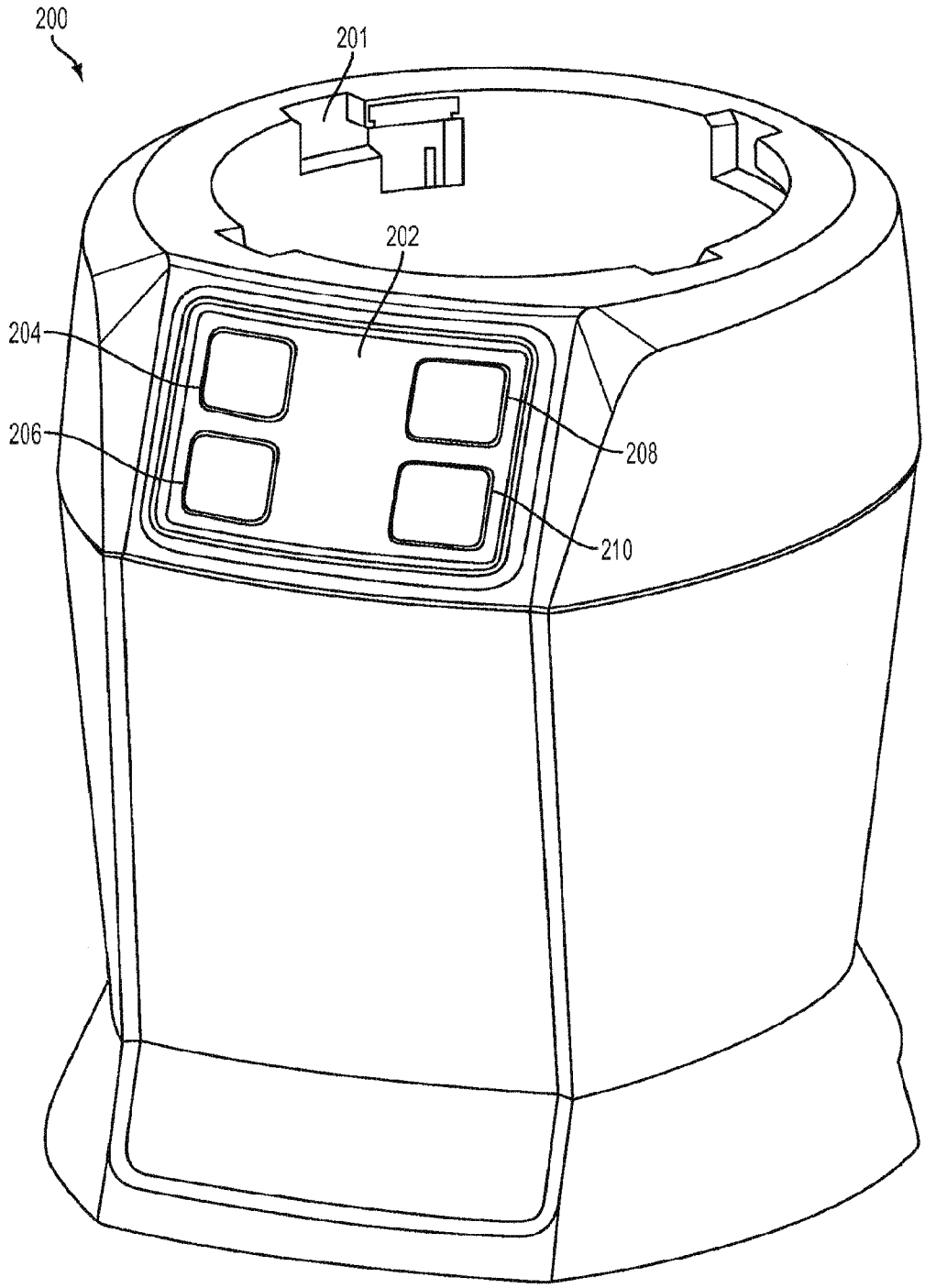
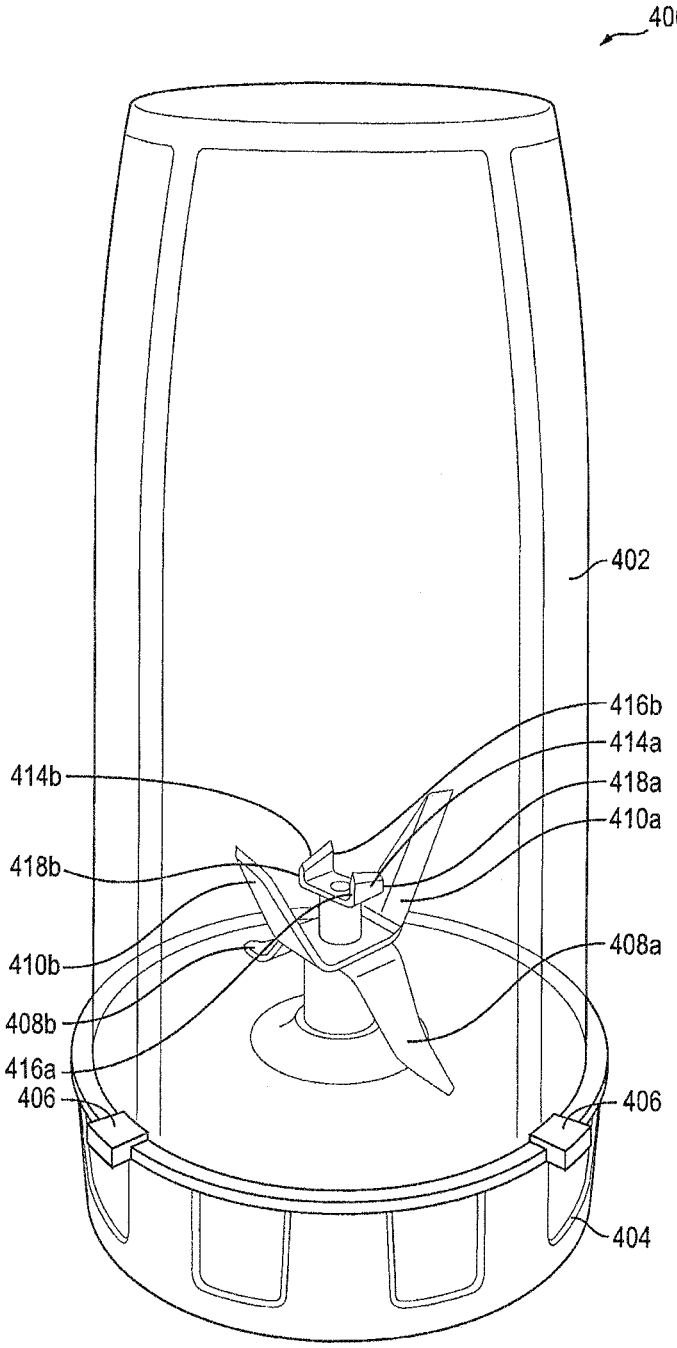



FIG. 2


400
402
416b
414a
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410a
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410b
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416a
406
406
404

FIG. 3

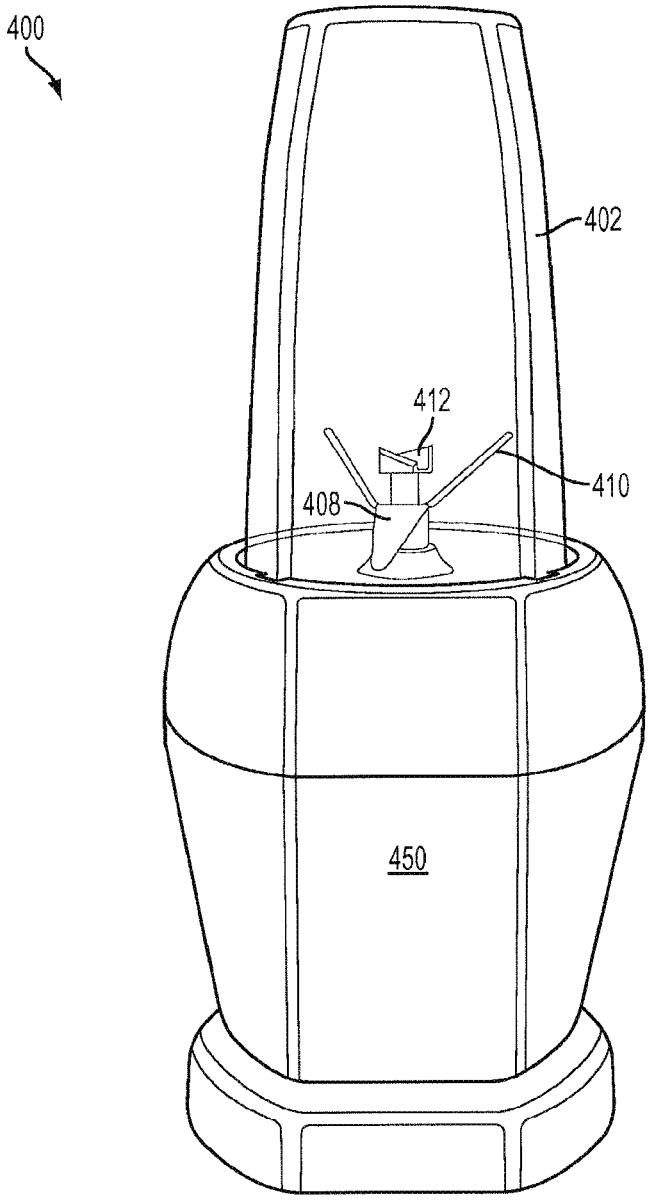



FIG. 4

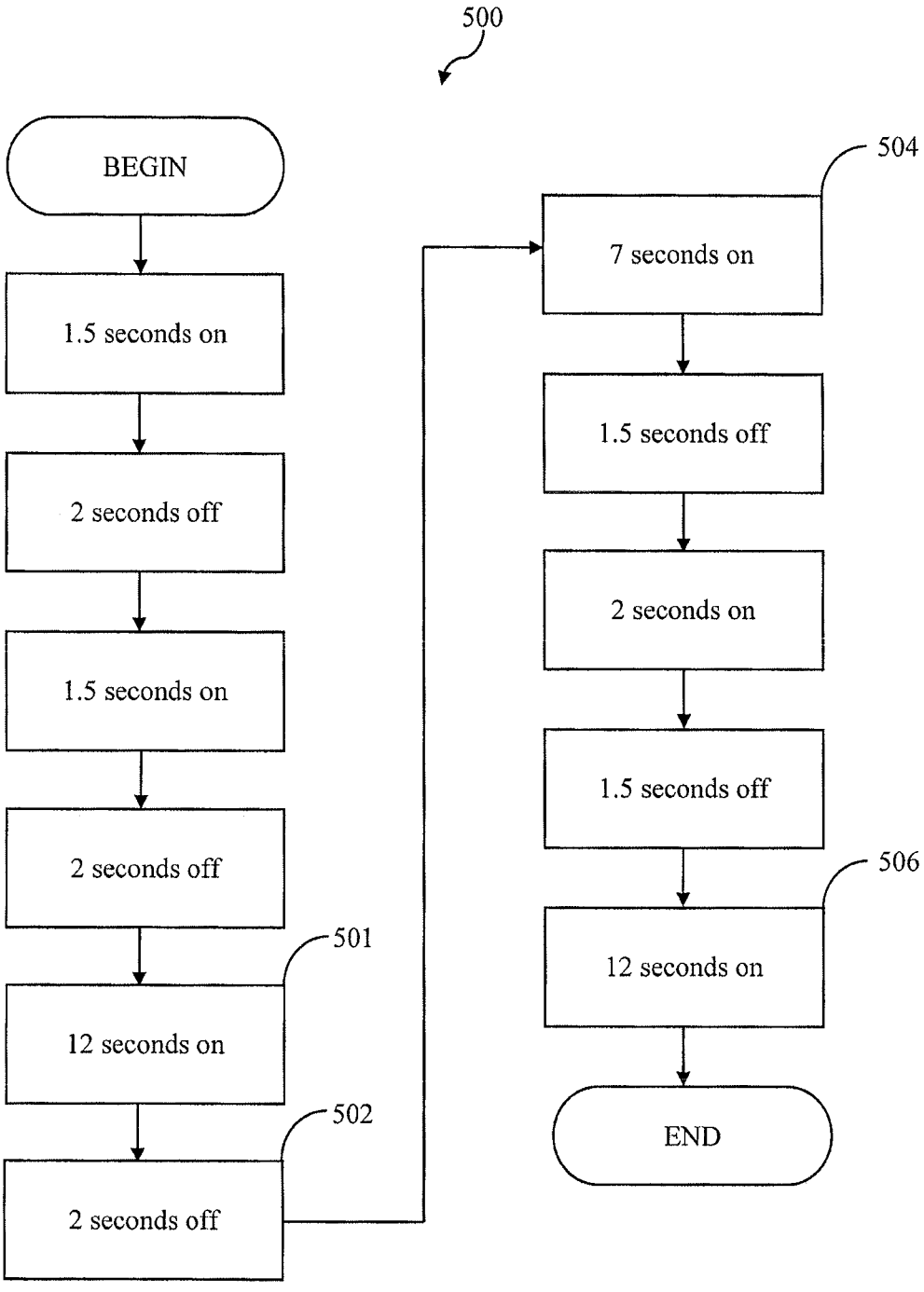
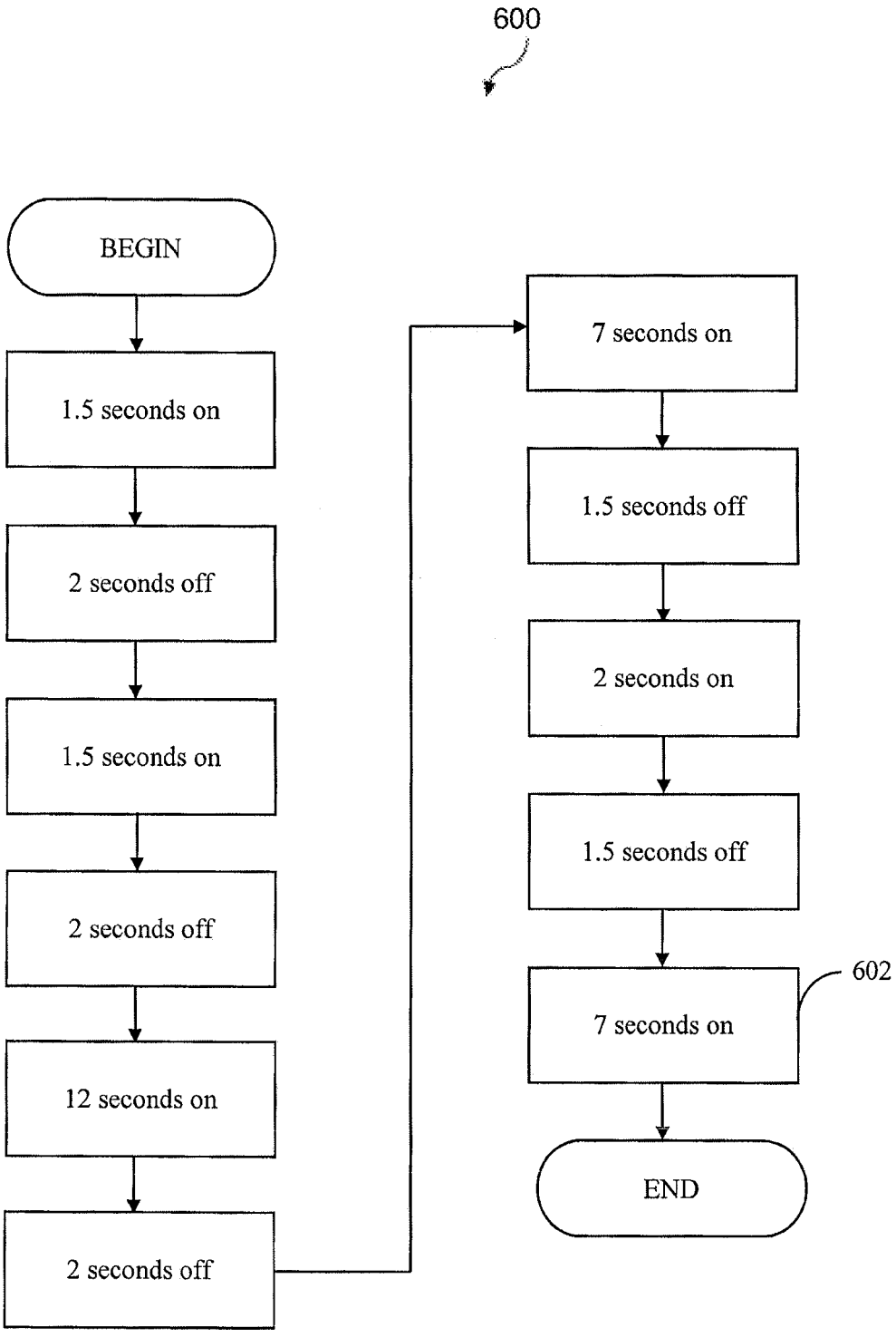

500
BEGIN
1.5 seconds on
2 seconds off
1.5 seconds on
2 seconds off
501
12 seconds on
502
2 seconds off
504
7 seconds on
1.5 seconds off
2 seconds on
1.5 seconds off
506
12 seconds on
END

Fig. 5


600
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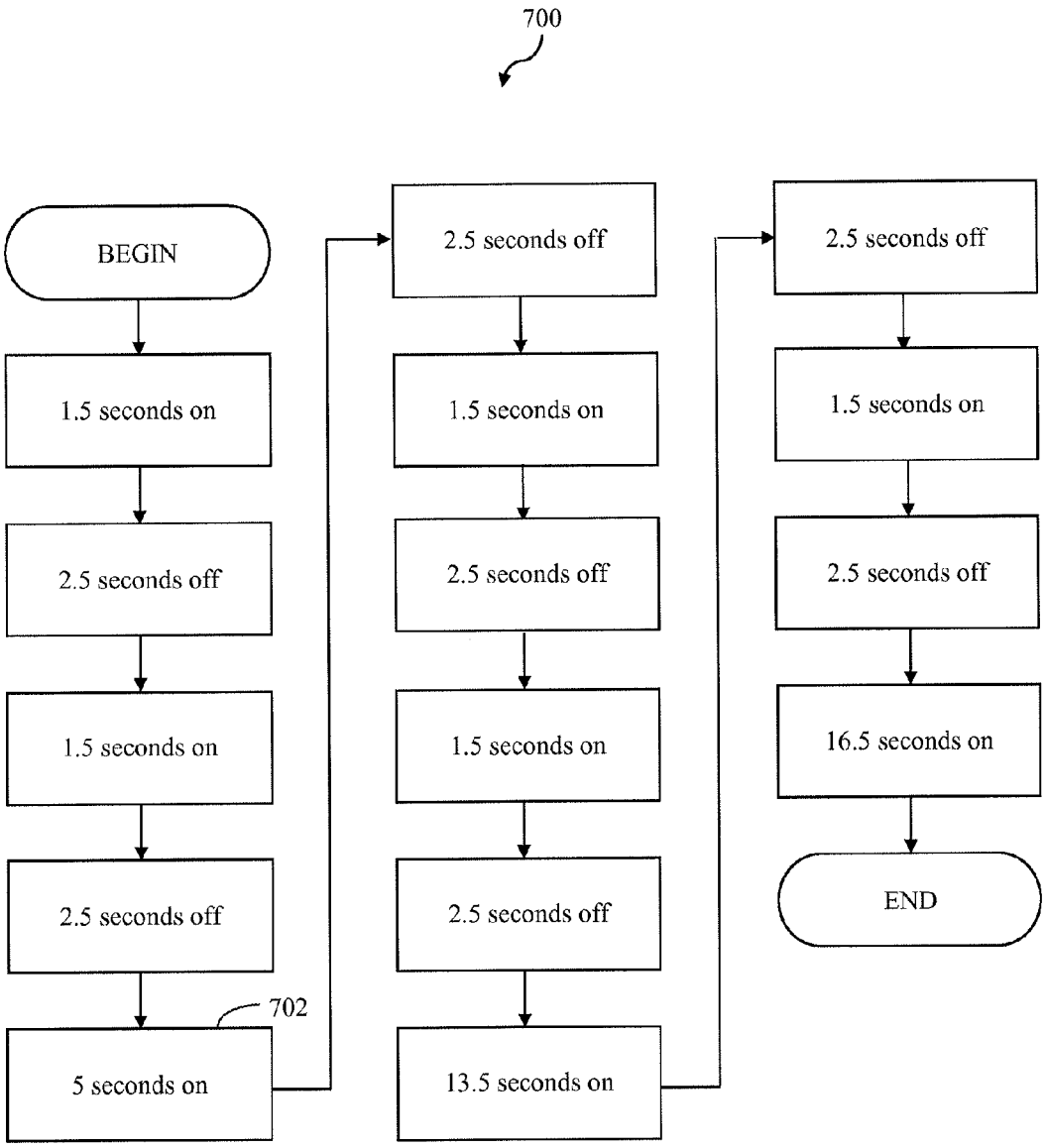
1.5 seconds on
2 seconds off
1.5 seconds on
2 seconds off
12 seconds on
2 seconds off
7 seconds on
1.5 seconds off
2 seconds on
1.5 seconds off
7 seconds on
602
END

Fig. 6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1.5 seconds on
2.5 seconds off
702
5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
13.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
16.5 seconds on
END

Fig. 7

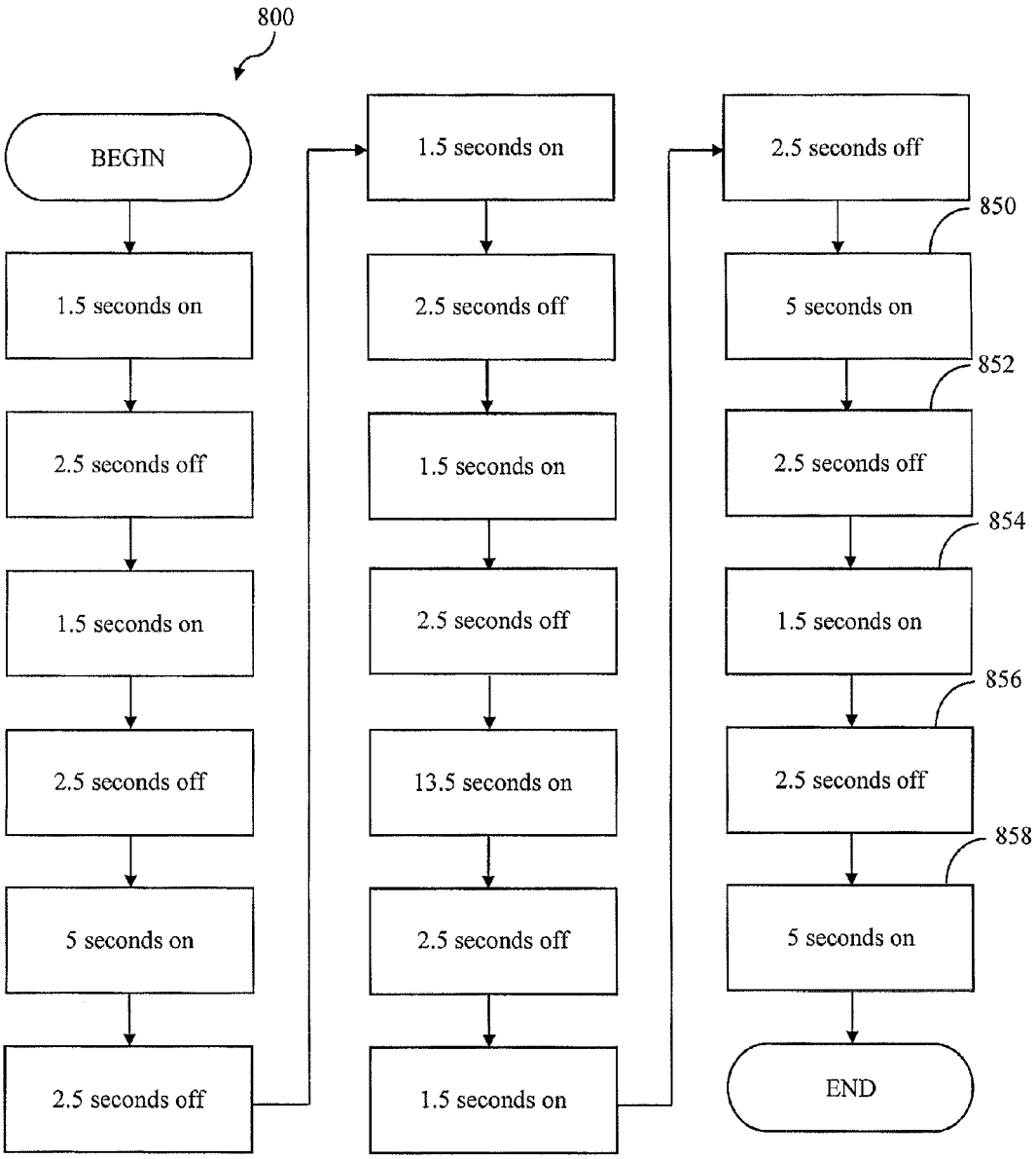

800
BEGIN
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
13.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
850
5 seconds on
852
2.5 seconds off
854
1.5 seconds on
856
2.5 seconds off
858
5 seconds on
END

Fig. 8

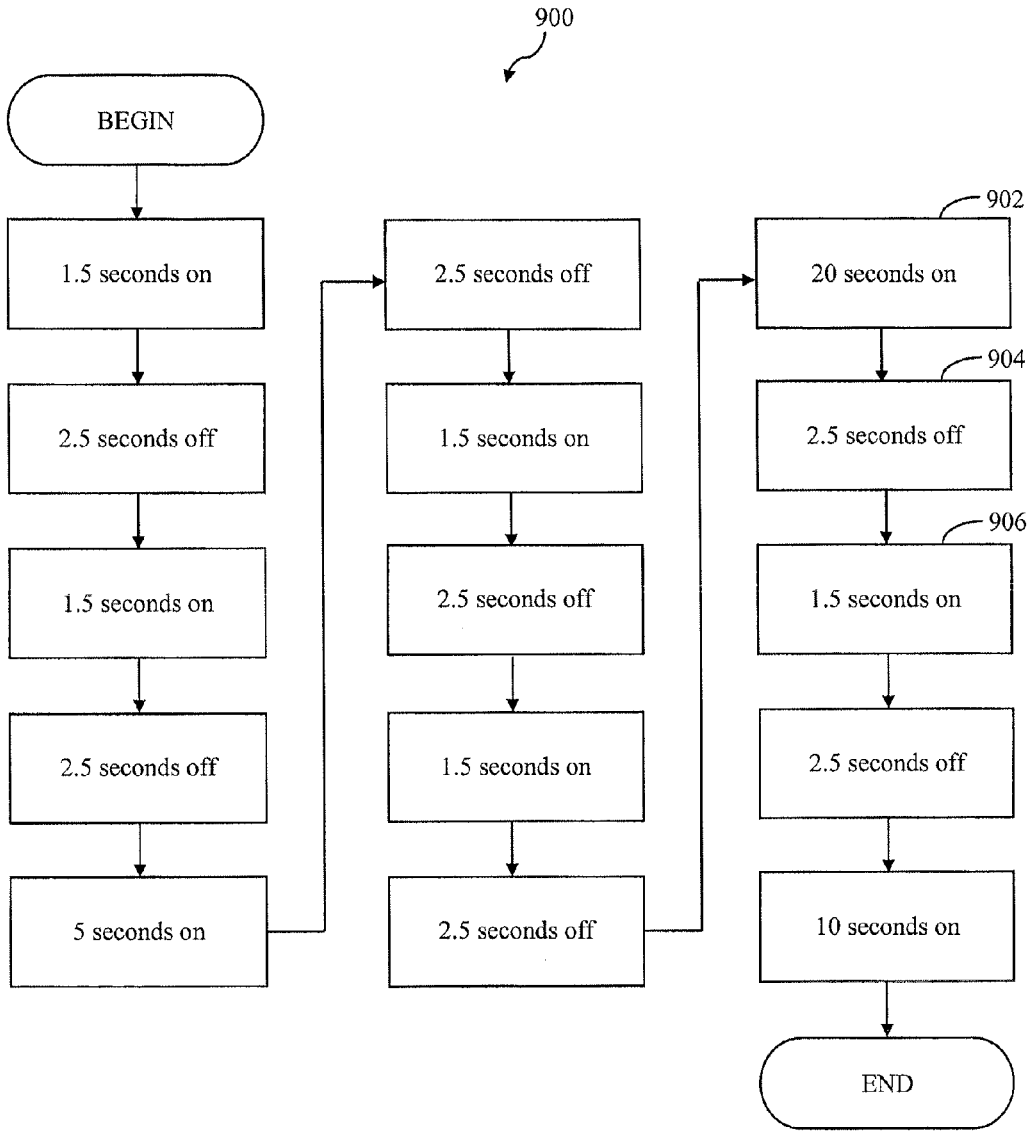
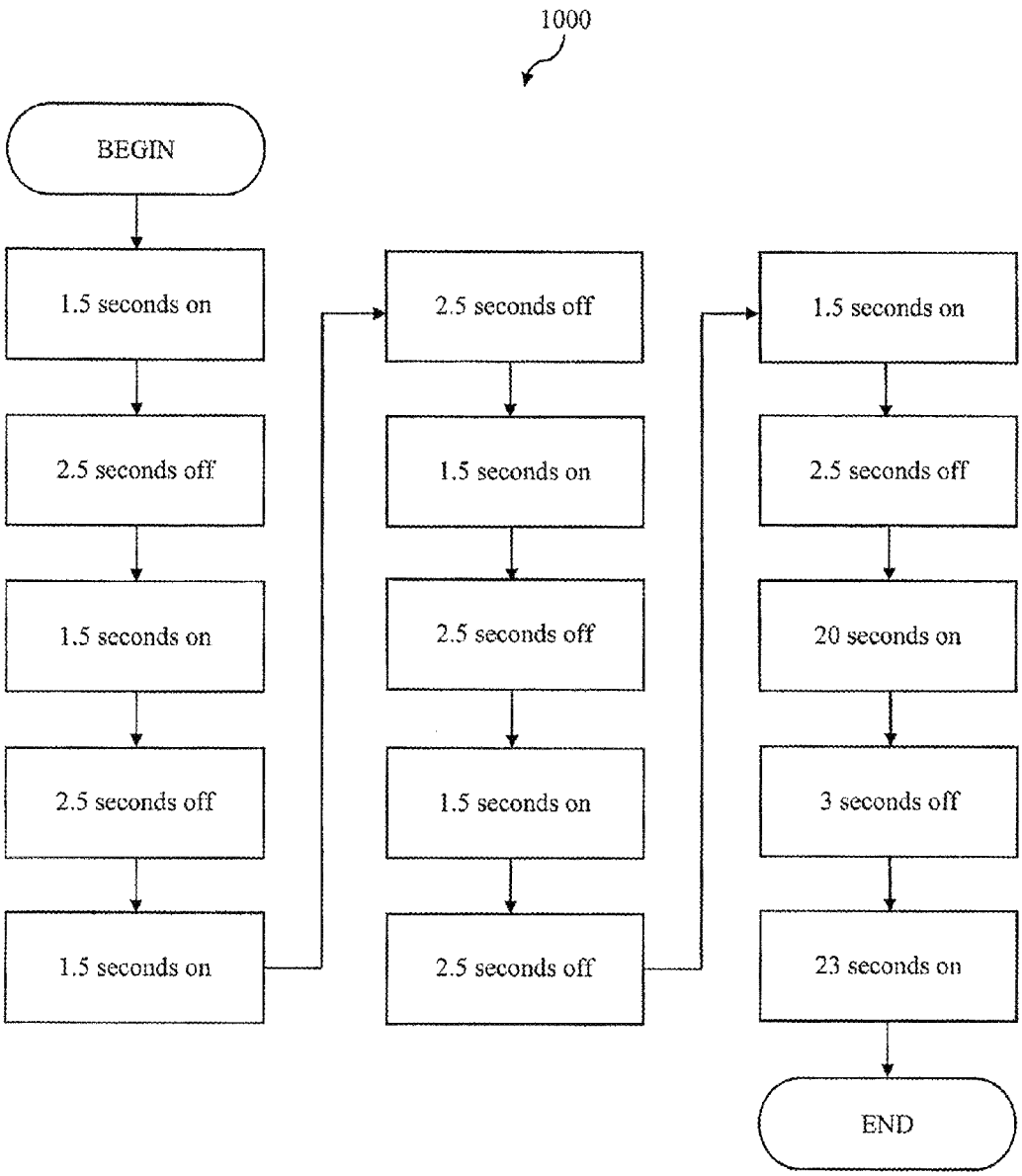

900
BEGIN
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
902
20 seconds on
904
2.5 seconds off
906
1.5 seconds on
2.5 seconds off
10 seconds on
END

Fig. 9


1000
BEGIN
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2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
20 seconds on
3 seconds off
23 seconds on
END

Fig. 10

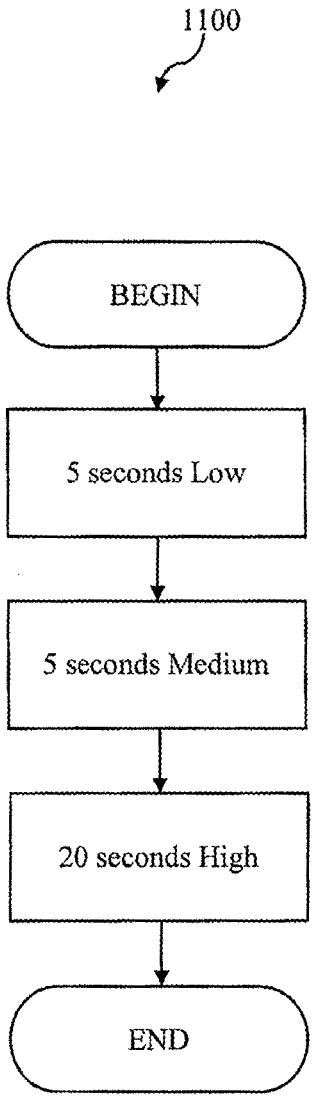

1100
BEGIN
5 seconds Low
5 seconds Medium
20 seconds High
END

Fig. 11A

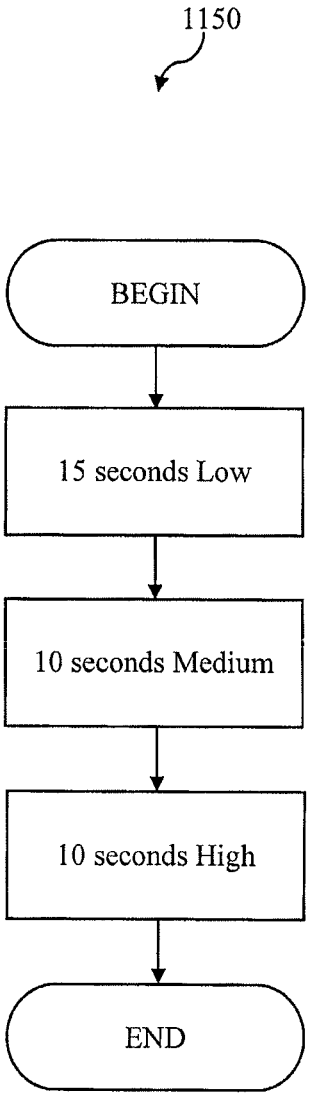
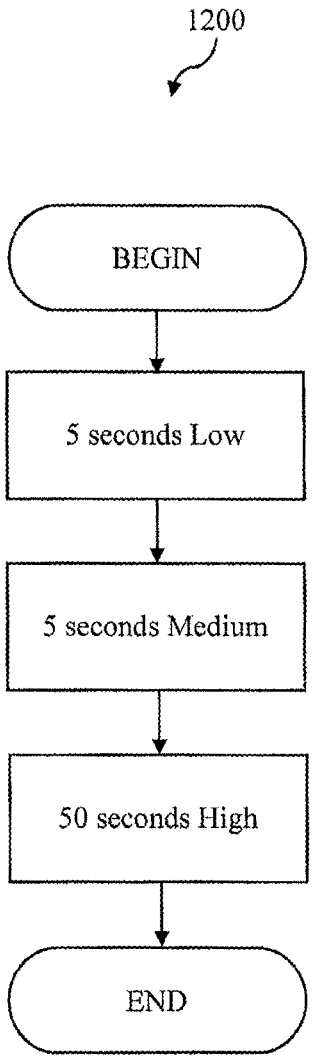

1150
BEGIN
15 seconds Low
10 seconds Medium
10 seconds High
END

Fig. 11B


1200
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5 seconds Medium
50 seconds High
END

Fig. 12

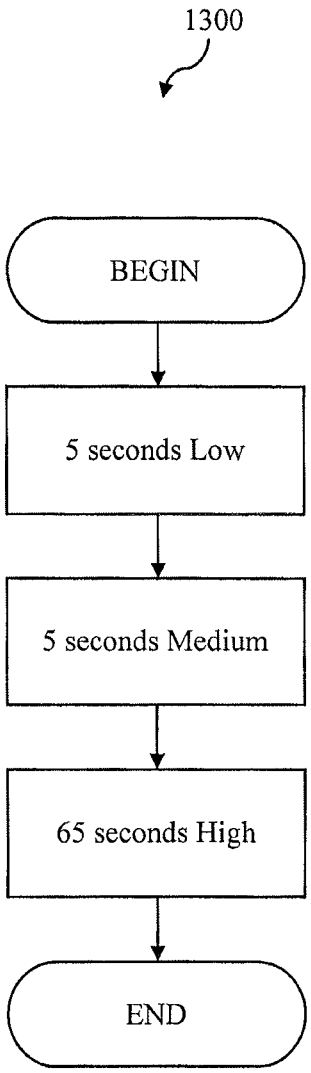
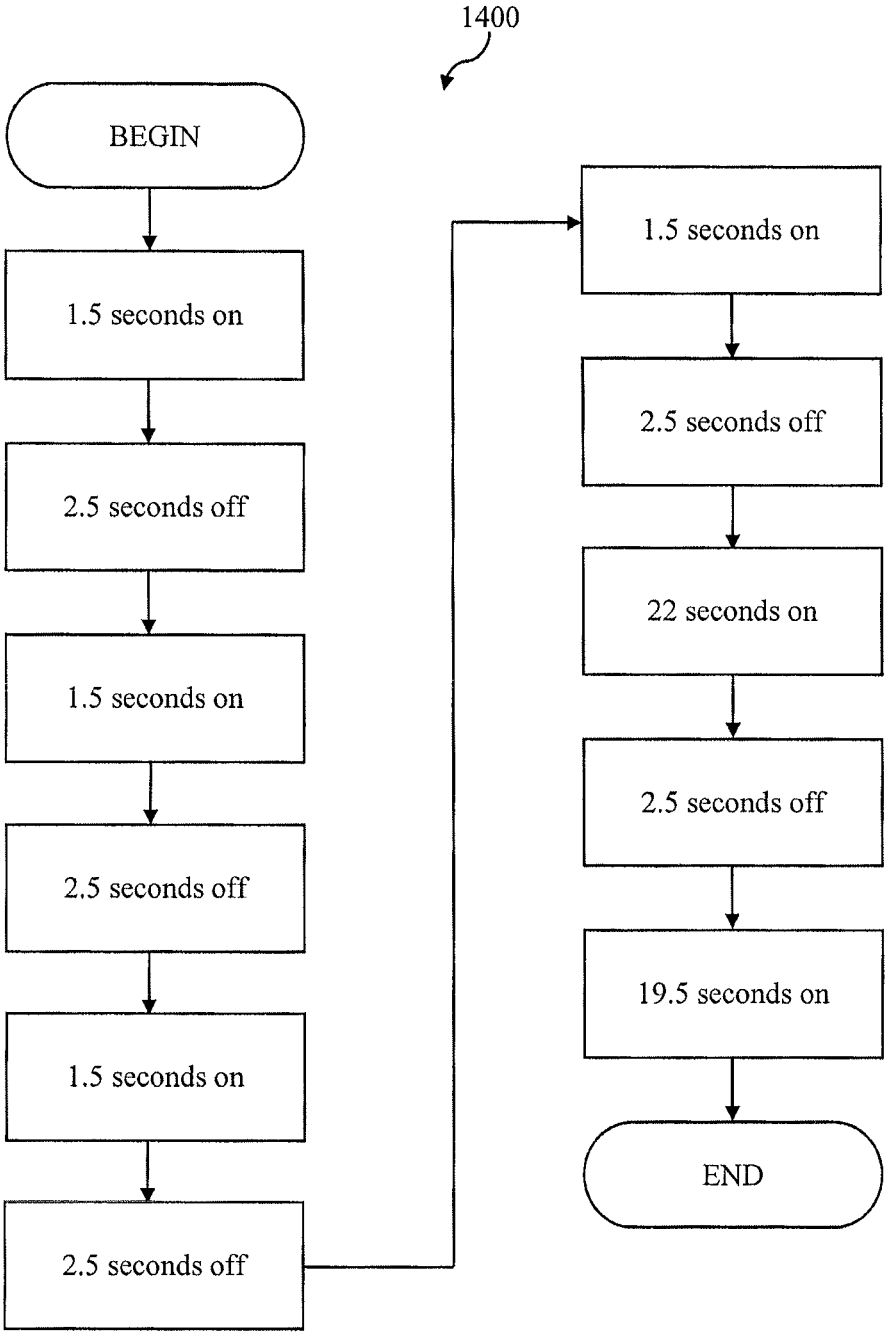

1300
BEGIN
5 seconds Low
5 seconds Medium
65 seconds High
END

Fig. 13


1400
BEGIN
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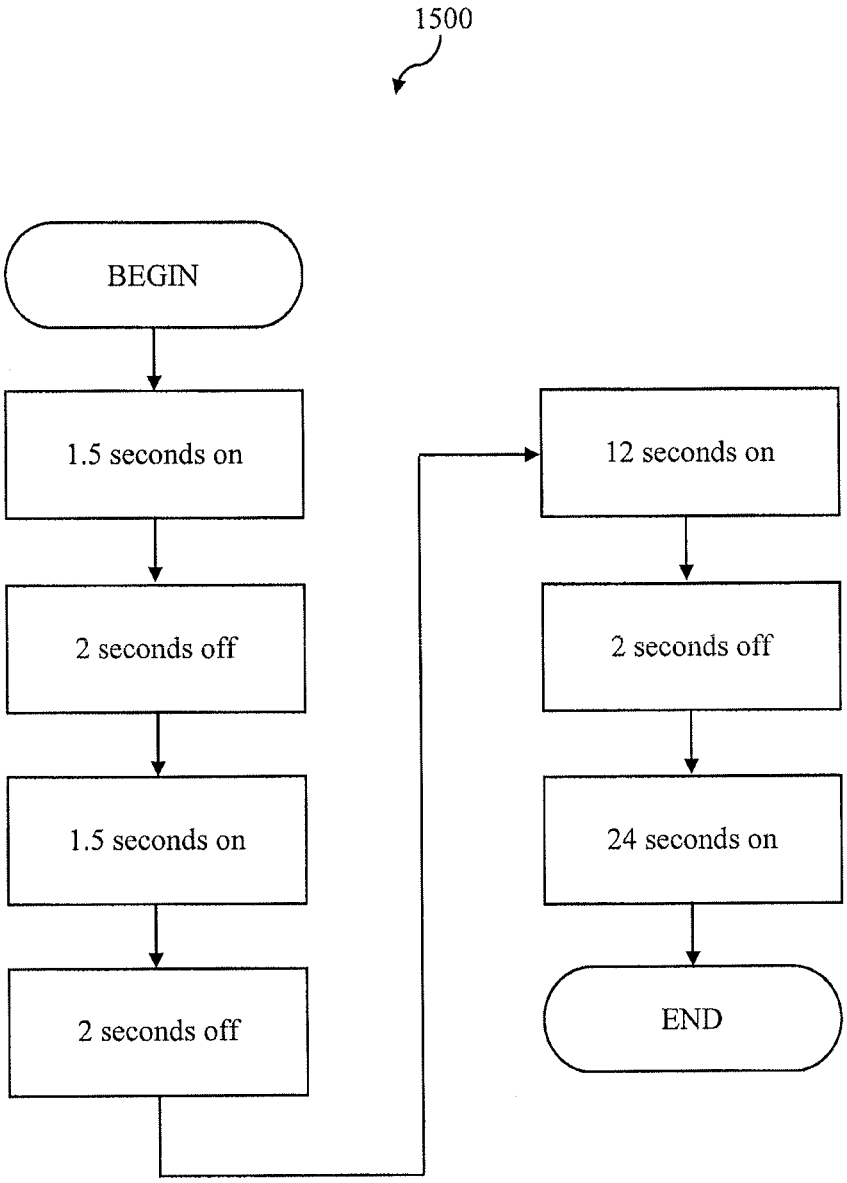
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
22 seconds on
2.5 seconds off
19.5 seconds on
END

Fig. 14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2 seconds off
12 seconds on
2 seconds off
24 seconds on
END

Fig. 15

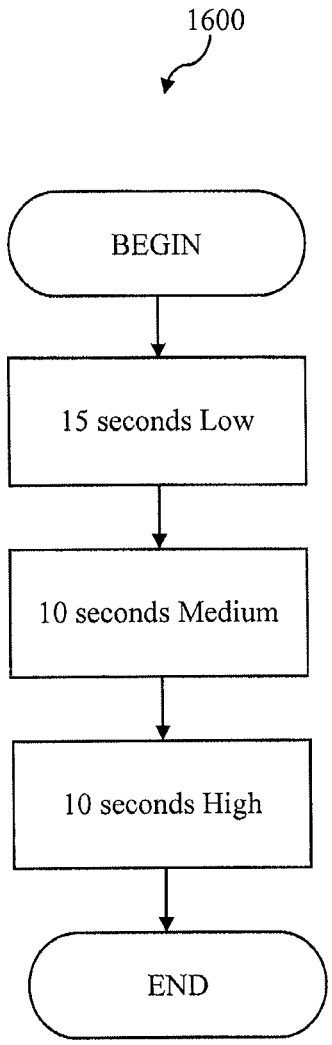
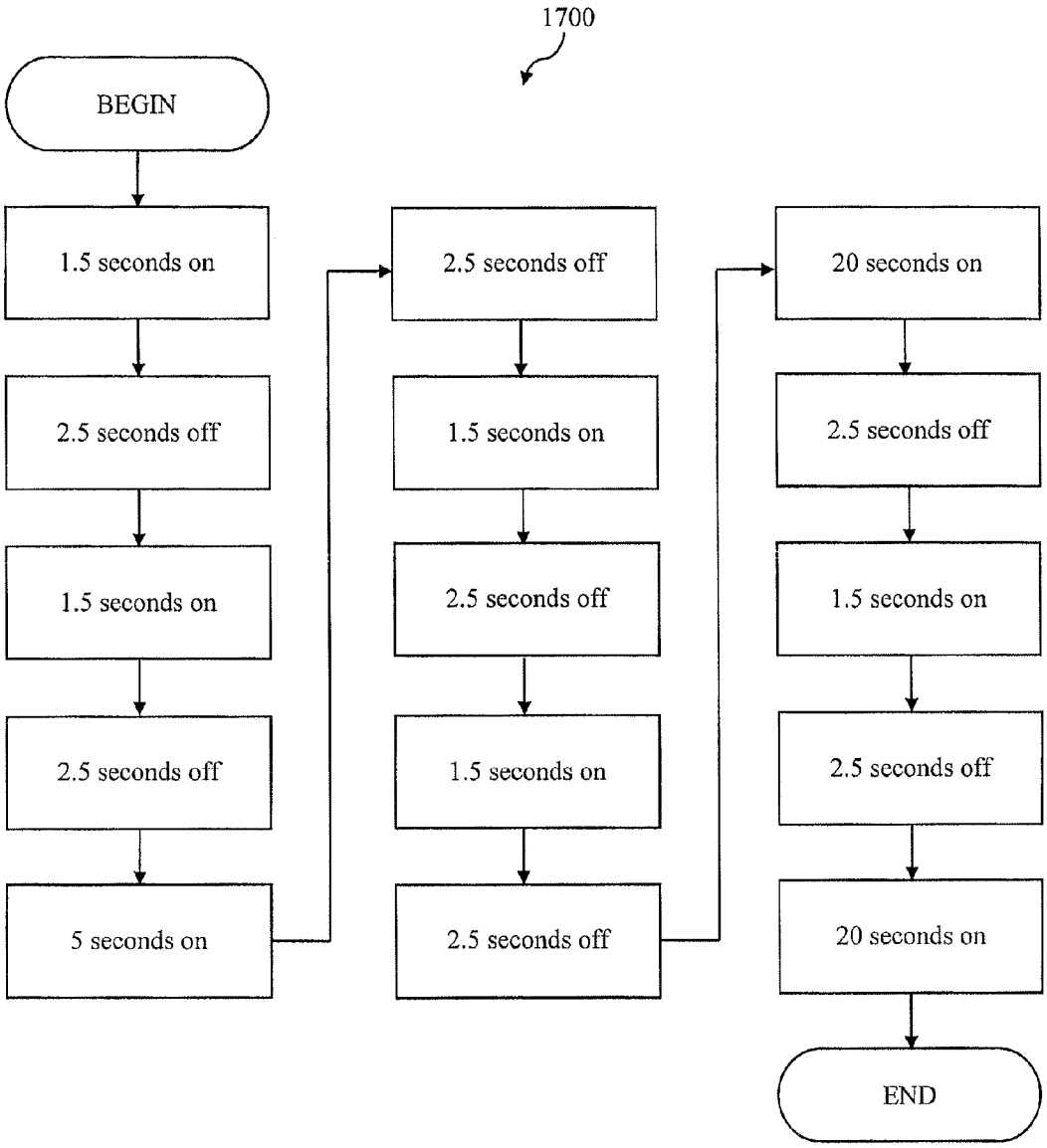

1600
BEGIN
15 seconds Low
10 seconds Medium
10 seconds High
END

Fig. 16


1700
BEGIN
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2.5 seconds off
1.5 seconds on
2.5 seconds off
5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
20 seconds on
2.5 seconds off
1.5 seconds on
2.5 seconds off
20 seconds on
END

Fig. 17

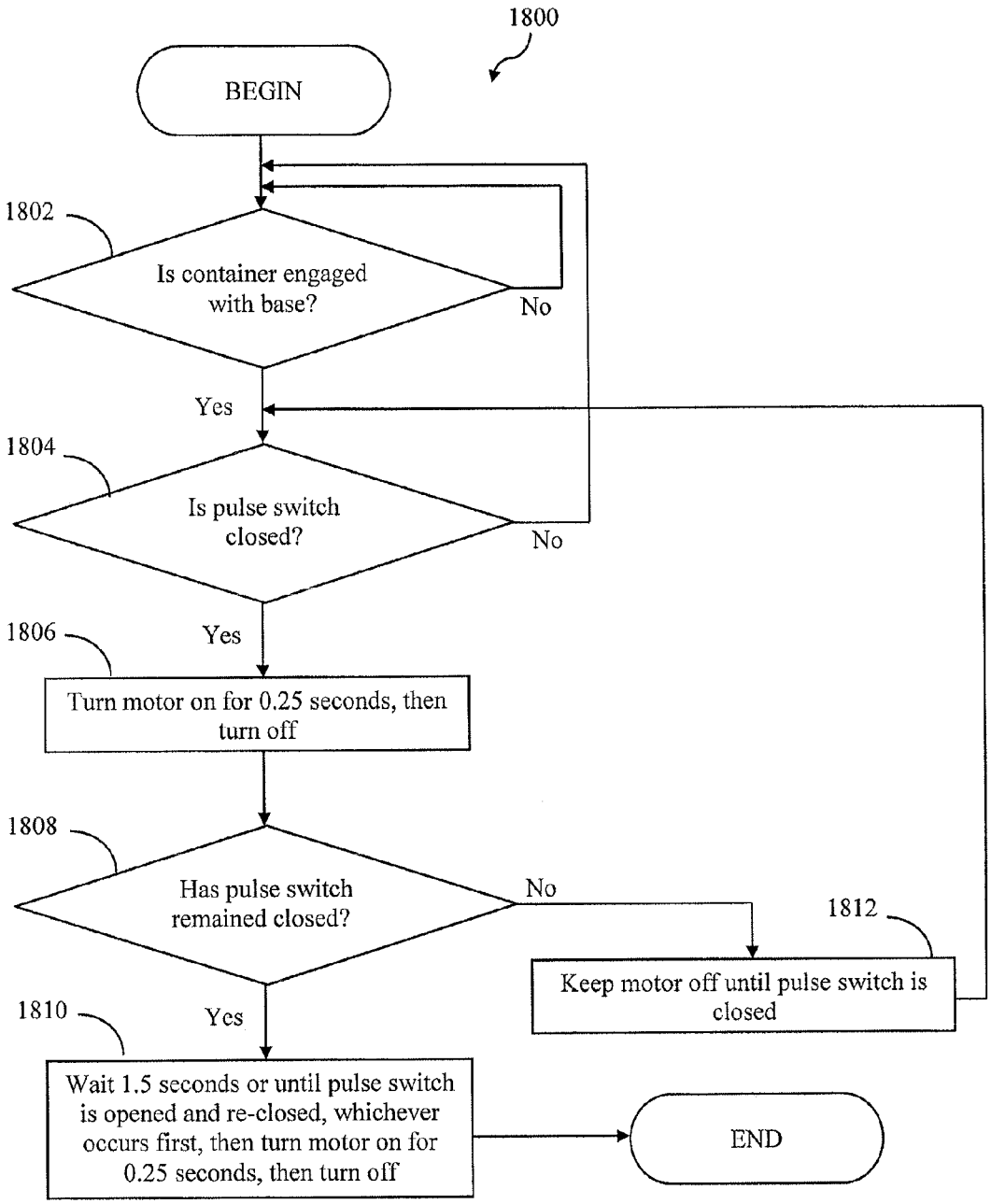
1800
BEGIN
1802
Is container engaged with base?
No
Yes
1804
Is pulse switch closed?
No
Yes
1806
Turn motor on for 0.25 seconds, then turn off
1808
Has pulse switch remained closed?
No
1812
Keep motor off until pulse switch is closed
1810
Yes
Wait 1.5 seconds or until pulse switch is opened and re-closed, whichever occurs first, then turn motor on for 0.25 seconds, then turn off
END

FIG. 18

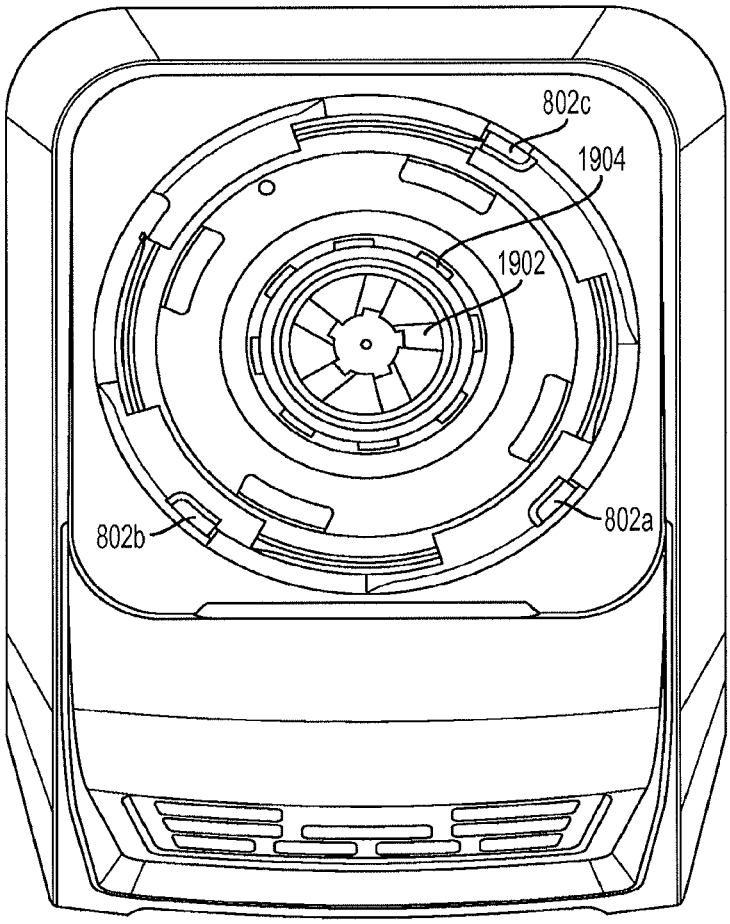


FIG. 19

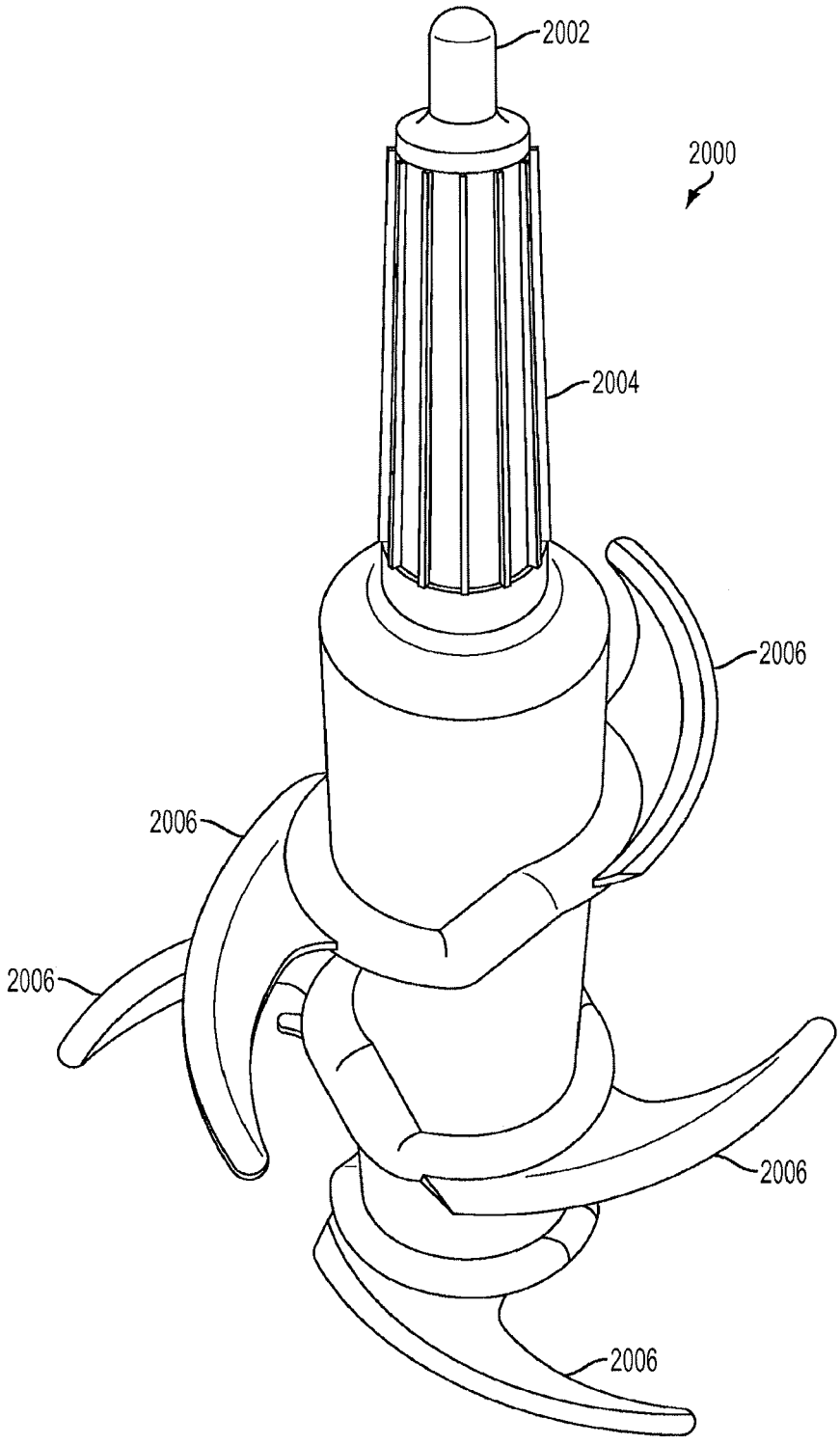


FIG. 20

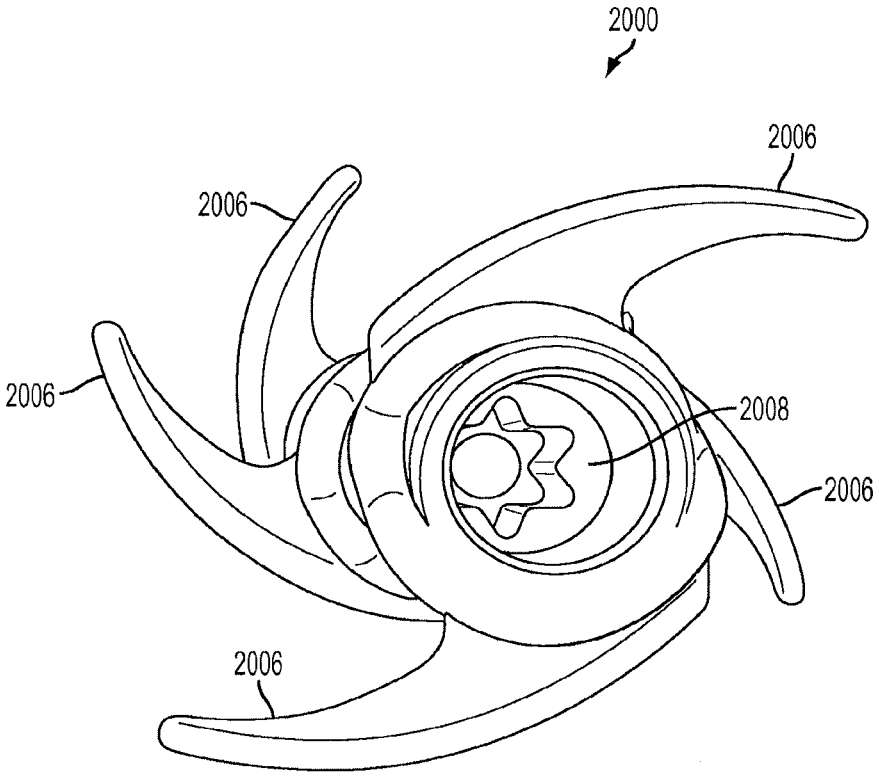


FIG. 21

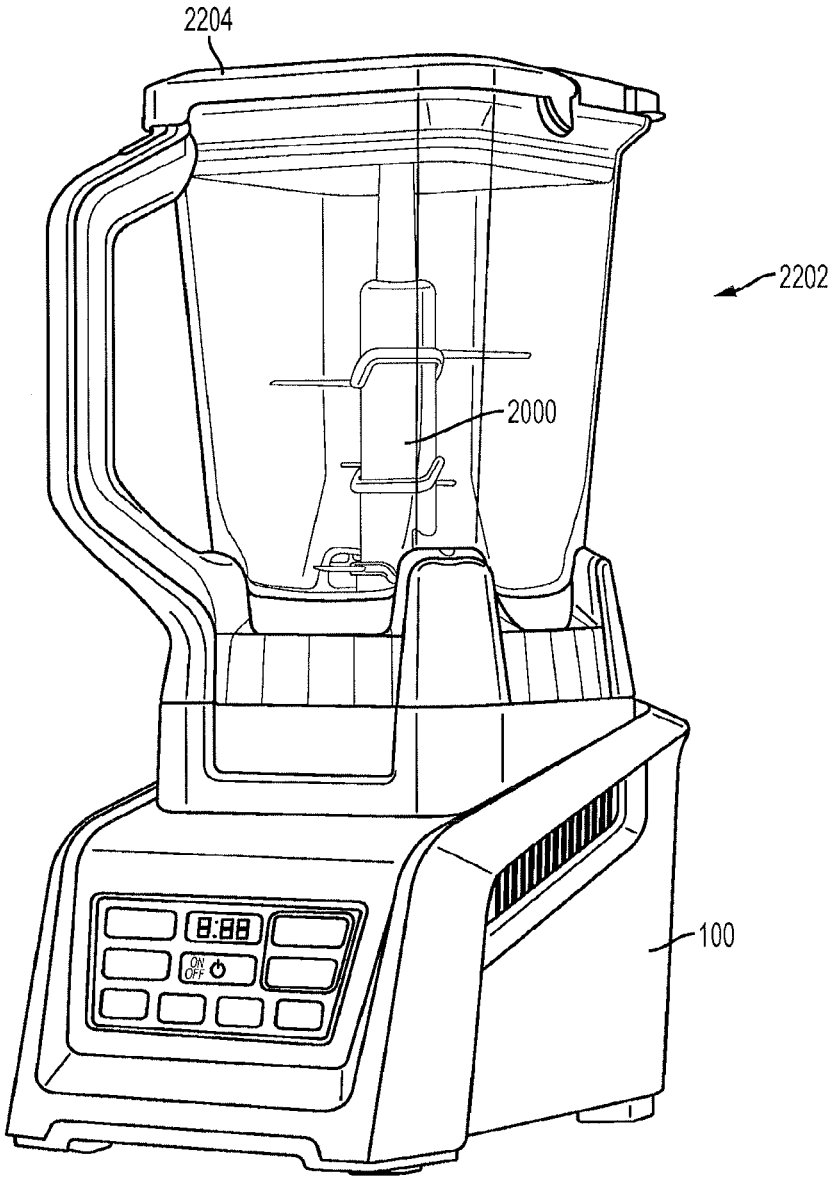


FIG. 22

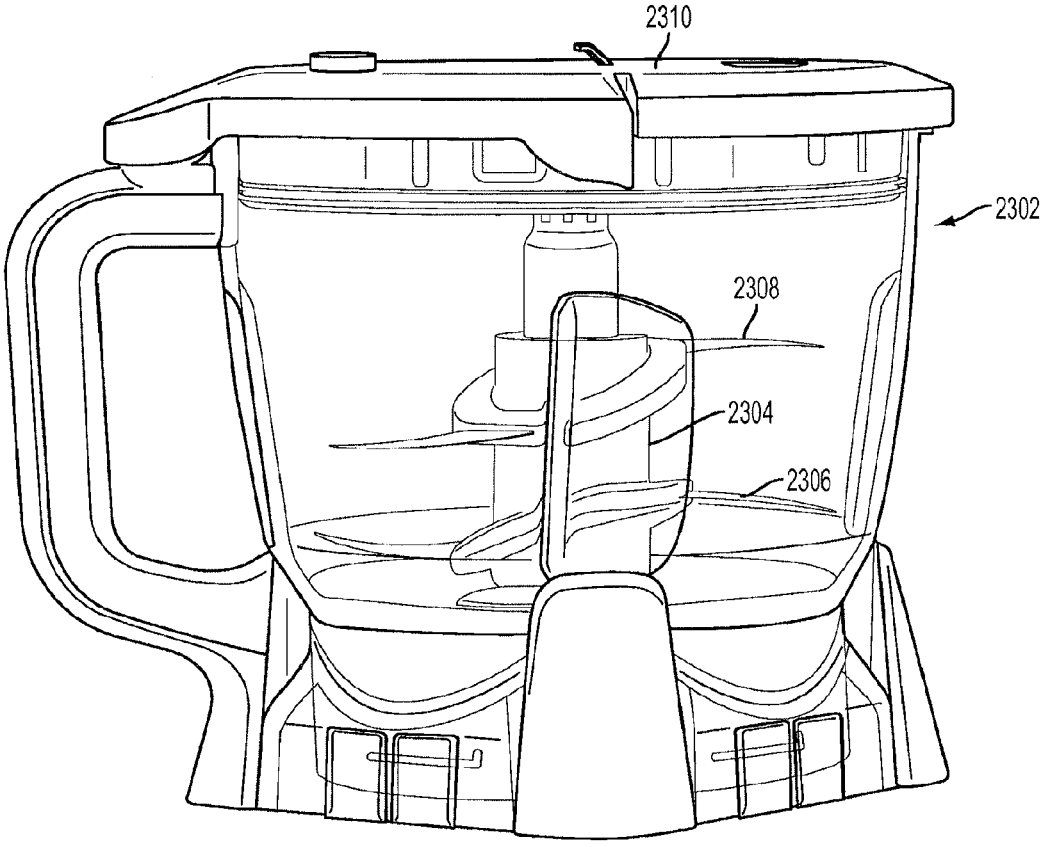


FIG. 23

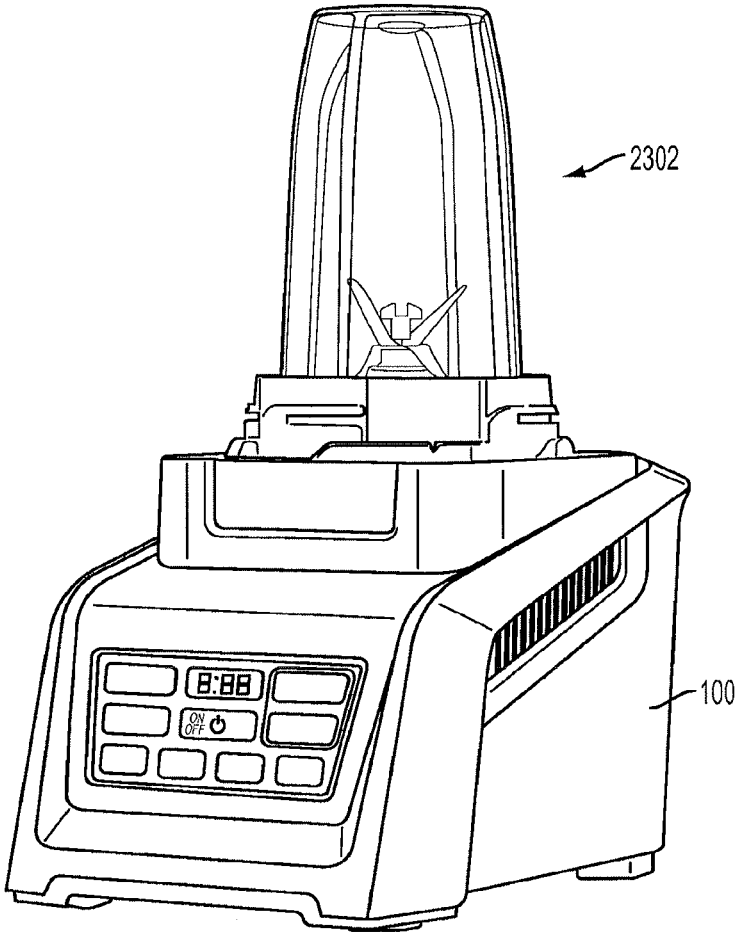


FIG. 24

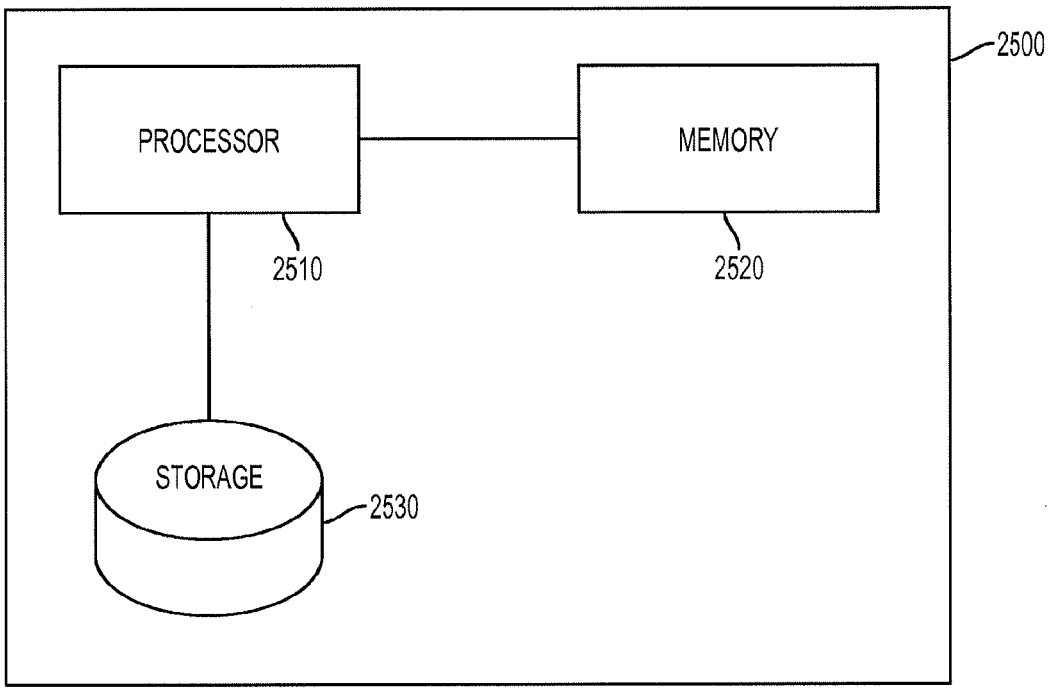


FIG. 25

# FOOD PROCESSING APPARATUS AND METHOD

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 14/468,941, entitled "Food Processing Apparatus and Method," filed Aug. 26, 2014, which claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Application Ser. No. 62/035,306, filed on Aug. 8, 2014 and entitled, "Food Processing Apparatus and Method," each of which is incorporated by reference. This application also claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Application Ser. No. 62/035,306, filed on Aug. 8, 2014 and entitled, "Food Processing Apparatus and Method."

## FIELD

Aspects herein generally relate to a food processing apparatus and to a method of processing food using a food processing apparatus. More specifically, aspects disclosed herein relate to a food processing apparatus having stored sequences that can be used to prepare various foods in an effective and convenient manner.

## DISCUSSION OF RELATED ART

Blenders and other food processors are typically used to chop, blend, mix, or pulverize food, crush ice, mix liquids, and blend liquid and solid food together using blades or other processing tools. Typically, the processing tools are rotated at various speeds within a container.

## SUMMARY

According to one illustrative embodiment, a food processing apparatus includes a container including at least one rotatable, sharp blade, a drive unit having a drive coupler to rotate the at least one blade, and a controller to control the drive unit. The apparatus also includes at least one non-transitory memory storing processor-executable instructions that, when executed by the controller, cause the controller, in response to a first user input, to sequentially: activate the drive unit for three seconds or less to rotate the drive coupler as a first pulse; pause the drive unit for at least one second; activate the drive unit for at least five seconds to rotate the drive coupler as a first blending segment; pause the drive unit for at least one second; and activate the drive unit for at least five seconds to rotate the drive coupler as a second blending segment. A total time period of all activations of the drive unit that are at least five seconds for blending segments is at least twenty seconds.

According to another illustrative embodiment, a method is used in connection with operation of a food processing apparatus, the apparatus comprising a drive unit to drive a food processing assembly, a controller to control the drive unit, and at least one non-transitory memory storing processor-executable instructions that are executable by the controller to cause the controller to control the drive unit. The method includes, in response to a first user input, sequentially: activating the drive unit for three seconds or less to rotate the drive coupler as a first pulse; pausing the drive unit for at least one second; activating the drive unit for at least five seconds to rotate the drive coupler as a first blending segment; pausing the drive unit for at least one second; and activating the drive unit for at least five seconds to rotate the drive coupler as a second blending segment. A total time period of all activations of the drive unit that are at least five seconds for blending segments is at least twenty seconds.

According to a further illustrative embodiment, a food processing apparatus comprises a container including at least one rotatable, sharp blade, a drive unit having a drive coupler to rotate the at least one blade, and a controller to control the drive unit. The apparatus also includes at least one non-transitory memory storing processor-executable instructions that, when executed by the controller, cause the controller, in response to a first user input, to sequentially: activate the drive unit for three seconds or less to rotate the drive coupler as a first pulse; pause the drive unit for at least two seconds as first pause; activate the drive unit for three seconds or less to rotate the drive coupler as a second pulse; pause the drive unit for at least two seconds as second pause; activate the drive unit for three seconds or less to rotate the drive coupler as a third pulse; pause the drive unit for at least two seconds as third pause; activate the drive unit for three seconds or less to rotate the drive coupler as a fourth pulse; pause the drive unit for at least two seconds as fourth pause; activate the drive unit for at least fifteen seconds to rotate the drive coupler as a first blending segment; pause the drive unit for at least two seconds; and activate the drive unit for at least fifteen seconds to rotate the drive coupler as a second blending segment.



## BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings are not intended to be drawn to scale. In the drawings, each identical or nearly identical component that is illustrated in various figures is represented by a like numeral. For purposes of clarity, not every component may be labeled in every drawing. Various embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. **1** is a perspective view of a blender base in accordance with one aspect;

FIG. **2** is a perspective view of a blender base in accordance with one aspect;

FIG. **3** is a perspective view of a container with an attached blade assembly in accordance with one aspect;

FIG. **4** is a perspective view of the container of FIG. **3** attached to a blender base in accordance with one aspect;

FIG. **5** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **6** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **7** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **8** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **9** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **10** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **11**A is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **11**B is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **12** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **13** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **14** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **15** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **16** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **17** is a flow chart of an illustrative food processing sequence in accordance with one aspect;

FIG. **18** is a flow chart of an illustrative food processing algorithm in accordance with one aspect;

FIG. **19** is a top view of a blender base in accordance with one aspect;

FIG. **20** is a top perspective view of a set of blades in accordance with one aspect;

FIG. **21** is a bottom perspective view of a set of blades in accordance with one aspect;

FIG. **22** is a perspective view of container attached to a blender base in accordance with one aspect;

FIG. **23** is a side view of a container in accordance with one aspect;

FIG. **24** is a perspective view of container attached to a blender base in accordance with one aspect; and

FIG. **25** is a block diagram of an illustrative controller that may be used in implementing some embodiments.

## DETAILED DESCRIPTION

Food processors, such as a blender, typically include a processing tool, such as a blade or a blades, within a container, and an electric motor which rotates the processing tool via a drive coupling. Some food processors include a programmed controller which allows a user to select a specific, stored sequence of motor operation to rotate the blades. The inventors have appreciated that existing sequences have limitations, especially when attempting to process low liquid and/or fibrous foods with minimal or no user intervention.

According to aspects of embodiments disclosed herein, a processing sequence is particularly suited to processing food mixtures which include solid components. For example, a processing sequence includes a short run of a blade or blades to initially chop food and/or break down fibers, skins, seeds, and/or ice. After at least one pause to allow the food to fall toward the bottom of the container and/or toward the blade path, the sequence proceeds to a continuous processing time segment of at least five seconds to crush and/or start liquefying the ingredients. At least another pause follows, and then a further continuous segment of at least five seconds to liquefy the contents of the container. By using such a sequence, smooth liquids may consistently be created even when blending ingredients which are difficult to liquefy. In some embodiments, the breakdown of fibrous ingredients helps to create a drink which has a smooth consistency and includes extracted nutrients. Longer times may be used in some embodiments. For example, in some embodiments, the total processing time of the longer blending segments may be at least twenty seconds. In some embodiments, the pause segments include a stoppage of the blade, while in other embodiments, the pause embodiments include the blade slowing to an rpm of 100 rpm or less.

According to another aspect of embodiments disclosed herein, a food processing apparatus is programmed to include an act of causing blended components to move along an inner side wall of the blender container upwardly toward the upper end of the blender container, to remove ingredients that may be caught on the inner wall of the container, or even on the underside of a lid of the container. In this manner, ingredients stuck on the inner side wall and/or lib may be returned to the blended mixture and processed with the blades.

For example, when processing foods, especially leafy greens or other foods with a high ratio of surface area to weight, food portions may be propelled toward the upper end of the container and stick to the inner walls, especially during the early stages of a sequence when solid food has not yet been chopped into small pieces. According to embodiments herein, after sufficient blending has occurred to at least partially liquefy the contents within the container, the blades or other processing tool may be stopped or slowed to a speed at which the liquid slows down and is substantially level within the container. The blades then may be quickly accelerated to drive the liquid outwardly and upwardly along the inner walls of the container. The liquid contacts the items caught on the container walls, and dislodges them so that they fall back into the mixture being blended. In some embodiments, the motor is instantaneously powered with full power to accelerate the blades.

The inventors have appreciated that in certain circumstances, providing control of one or more specific parameters to a user during the operation of a program can permit improved food processing results.

For example, according to one embodiment disclosed herein, a programmed food processing sequence includes a series of on/off pulses. That is, the blades are driven for an amount of time, then stopped for an amount of time, again driven for an amount of time, and then stopped. This sequence may be repeated any suitable number of times, and can be helpful for initially chopping solid food ingredients, and then letting the ingredients move toward the bottom of the container and/or toward the horizontal center of the container while the blades are stopped. In this manner, when the blades are restarted, more of the ingredients are within reach of the blades and/or in an area where they will be drawn toward the blades. According to embodiments herein, while the amount of time that the one or more blades (or other processing tool) are driven is set by the program and not alterable by the user during operation, the user is able to choose a suitable amount of time for each "off" time period while operating the blender. This particular arrangement is unlike typical programmed blenders which have preset amounts of time for both the "on" periods and the and "off" periods which the user cannot modify during operation.

The inventors have appreciated that when manually pulsing a blender, users often keep the motor on for too long, which can result in blending rather than chopping or pulverizing. The inventors have also appreciated that programming a blender controller with a suitably long pulse sequence to accommodate a range of ingredient mixtures can lead to "off" time periods which are unnecessarily long in some circumstances. In certain embodiments disclosed herein, a programmed pulse sequence includes preset "on" times, followed by a default "off" time which a user can shorten in any suitable manner, for example by letting go of a button and then re-pressing the button. A second, preset "on" time follows the "off" time. In this manner, the programmed blender can prevent overly long "on" times while also avoiding overly long "off" times.

According to another aspect of the disclosure, processing sequences particularly suited for pureeing foods are disclosed herein. According to one embodiment, a blender starts a sequence by reaching a steady-state low rotational blade speed, and after at least five seconds at the low speed, increases to a steady-state medium rotational blade speed, and after at least five seconds at the medium speed, increases to a steady-state high speed. In some embodiments, the high speed continues for an amount of time that is longer than the low speed and medium speed times combined. Such a sequence provides initial segments which break down ingre-

dients such that during the high speed segment, cavitation can be avoided while running at a speed that efficiently creates a smooth texture.

In some embodiments, the progression of speeds for pureeing is performed in conjunction with a set of stacked blender blades which each have a substantially flat arrangement and a curved leading edge. The sequence may be configured such that the blade speed does not fall below any prior steady-state blade speed until the end of the steady-state high blade speed time period.

Particular stored sequences may be indicated as being available for use via indicators associated with stored sequence buttons. In some embodiments, particular stored sequences may be useable only with one or more types of containers. To indicate the availability of stored sequences for a particular container attached at a given time, the food processor may be configured to determine which type of container is attached, and a visual cue may be provided to the user as to which stored sequence(s) may be used. For example, in one embodiment, a controller illuminates a light associated with a specific button to indicate that the stored sequence (or other functionality) corresponding to that button (or other input) may be used. The button may have a particular sequence name or functionality name printed on or near the button.

According to another aspect of embodiments disclosed herein, a same button, or other input, may be used to initiate different stored sequences depending on what type of container is attached to the food processing apparatus.

Control Panel

FIG. **1** shows one embodiment of a blender base **100** with a control panel **102** and a container interface **104** for attaching a container to the base. The blender base **100** includes a drive unit (not shown), such as an electric motor and a drive coupler which can be mated to a driven coupler on an attached container. A controller (not shown in FIG. **1**) is included for controlling the drive unit, in some cases to execute stored sequences of motor operation.

The control panel includes a number of buttons **106**, **108**, **110**, **112**, **114**, **116**, **118**, **120**, and **122** in the illustrated embodiment, though any suitable structure for receiving user input may be utilized. Button **106** is an on/off button which allows the user to activate or deactivate the control panel. When the control panel is deactivated, the motor is not powered.

Button **108** activates the motor to run at a "low" speed by supplying a certain amount of power to the electric motor. The actual speed of the motor and hence the speed of the blades or other processing tool may vary based on the type and consistency of food within the container. In some embodiments, a feedback control may be provided which senses the speed of the motor or other components, and adjusts the electric power to maintain a certain speed or speed profile. In some embodiments, for example, in personal serving containers, a target motor rotational speed of approximately 7,000 rpm is activated by the button **108** with the container substantially full of liquefied food. Similarly, button **110** activates a medium speed, which may be an approximate target rotational speed of 9,000 rpm in some embodiments with the container substantially full of liquefied food. Button **112** activates a high speed, which may be an approximate target rotational speed of 11,000 rpm in some embodiments with the container substantially full of liquefied food.

Buttons **114**, **116**, **118**, **120** activate stored sequences according to embodiments disclosed herein. In some cases, a stored sequence is designed to be particularly well suited for a class of food preparation and/or particular ingredients or types of ingredients. The particular stored sequence that is activated by a given button may vary depending on the type of container that is attached to the blender base so that the food preparation may be enhanced further.

For example, in the illustrated embodiment, button **114** activates a sequence of motor control which rotates a set of blades to produce frozen drinks having a high degree of ice pulverization in an efficient manner. The particular sequence may vary depending on the size and/or type of container attached to the blender base. Button **116** invokes a sequence particularly well suited for preparing purées, as described further below with reference to FIGS. **8**, **9** and **10**. Button **120** allows a user to select a stored sequence which targets the processing of frozen food items. A stored sequence aimed at blending fresh foods is activated with button **118**. In some embodiments, by pressing a single button once, a user can process foods that might typically require user intervention.

Button **122** activates a pulse sequence, which in some embodiments may permit a user to alter the sequence while the blender is operating according to the pulse sequence. For example, in some embodiments, the button **122** may be used to activate a series of pulses where the motor is on for a set amount of time, but the length of time that the motor is off is adjustable by the user while pulsing.

Sequence Indicators

One or more of the buttons may include a light or other indicator to show that the respective button will initiate a function if actuated. For example, a light **130** may be illuminated on button **114** indicating that the frozen drinks sequence available for operation. If pressing button **114** will not result in motor activation, light **130** will not be illuminated. The illumination status of light **130** may be based on the type of container attached to the blender base or any other suitable parameter. For example, the food processing apparatus may include a weight sensor and/or a temperature sensor, and the availability of a given sequence or other function may be based on the measurements received from one or both sensors.

Personal Serving Embodiment

FIG. **2** shows another embodiment of a blender base **200** having a container interface **201** and a control panel **202** with a different arrangement of buttons as compared to the embodiment of FIG. **1**. Blender base **200** may be used with a personal serving container as shown by way of example in FIG. **3**. A button **204** may be used to start and stop the motor. A button **206** is used to initiate a pulse sequence, which in some embodiments permits a user to alter a length of a pauses between motor activations. A button **208** may be used to start a sequence directed at processing frozen food items. Fresh food items may be processed using a stored sequence initiated by a button **210**.

Other arrangements of buttons or other inputs may be used with any of the various embodiments disclosed herein. For example, dials, flip switches, rotary knobs, slide knobs, voice-activated commands, virtual keyboards, or any other suitable input may be used.

Motor

The motor contained within blender base **200** of FIG. **2** may be rated at 1,000 watts in some embodiments, though any suitable motor may be used. In some embodiments, the motor may be run at full power, while in other embodiments, the motor may be run at less than full power, even when on a "high" setting. The motor may be configured to run at approximately 20,000 RPM when unloaded. In some embodiments, the motor can be run with different power inputs for different sequences, or run at different power inputs

within a single sequence. In other embodiments, the motor is run with the same power input for all stored sequences.

The motor contained within blender base **100** of FIG. **1** may be rated at 1,500 watts in some embodiments, though any suitable motor may be used. The motor may be run at least than full power at times. For example, the motor may be run at 85% of full power, or any other suitable percent of power in some embodiments, when being operated with the personal serving container shown in FIG. **3** and a "high" setting is selected by the user or is part of a stored sequence. See FIG. **24** for one embodiment of a personal serving container mounted to the base of FIG. **1**. With a 1,500 watt motor, the 85% power input results in a rotation speed of approximately 21,500 rpm when unloaded. For medium settings, the motor may be supplied with 80% power input, resulting in a rotation speed of approximately 20,000 rpm when unloaded. For low settings, the motor may be supplied with 60% power input, resulting in a rotation speed of approximately 15,000 rpm when unloaded. When used with the container shown in FIG. **22**, the motor may be run at 100% power, and rotate at approximately 24,000 rpm when unloaded. Any suitably-sized motor and/or power input may be used in various embodiments.

For purposes herein, when a motor speed, processing tool speed, or drive coupler speed is discussed, a constant speed is not necessarily required. The speed may vary slightly over time as a result of intended changes to the power which is provided to the motor. Or, the speed may vary as a result of the food contents being processed in the container. For example, in some embodiments, a motor may be supplied with 85% of its full rated power, and the motor and blades may initially rotate at 8,000 rpm under the load of the unprocessed food in the container. As the food is processed, the blades become easier to rotate, and the motor speed may increase to 13,000 rpm even though the same amount of power is being supplied to the motor.

Personal Serving Container

FIG. **3** shows a container assembly **400** including a container **402** and a container base **404** which is removably attachable to the container **402** with threads (not shown). Container **402** includes four equally spaced engagement members, such as tabs **406** (only two are shown in FIG. **3**) which engage with slots in an associated blender base. In some embodiments, the tabs or other engagement members extends from the container base **404** instead of the container **402**. Container **402** may be used to prepare personal serving sizes which can be consumed directly from the container.

A processing assembly, such as a shaft supporting six blades **408***a*, **408***b*, **410***a*, and **410***b* is positioned within the container when the container base **404** is attached to the container. A driven coupler (not shown in FIG. **3**) is positioned on the underside of the container base to rotate the blades when attached to a blender base.

The container assembly **400** is shown in FIG. **4** mounted to a blender base **450**. The blender base **450** includes a motor which rotates a drive coupler (not shown in FIG. **4**), which in turn rotates the blades **408***a*, **408***b*, **410***a*, and **410***b* via the driven coupler on container base **404**.

Blades which are parallel to the axis of rotation, such as vertical blades **414***a*, **414** *b*, may be included in some embodiments. Vertical blades **414***a*, **414** *b* include upwardly-facing sharp edges **414***a*, **414***b* in some embodiments, and these sharp edges may be slanted relative to horizontal (or slanted relative to a plane that is perpendicular to the axis of rotation). Vertical blades **414***a*, **414***b* may oriented such that when rotated, the blades lead with taller side edges **416***a*, **416***b*. In other embodiments, the vertical blades **414***a*, **414***b* may be oriented to lead with short side edges **418***a*, **418***b*. The upwardly-facing edges may not be sharp in some embodiments. The vertical blades **414***a*, **414***b* may be used with various blending sequences or other food processing sequences described herein. In particular, these blades may be used with sequences which are particularly well suited to process ice or frozen foods.

As used herein, the term "processing tool" refers to any tool used to process foods and other materials. A processing tool may include, but is not limited to, one or more blades, one or more whisks, one or more ice crushers, one or more dicers, one or more graters, one or more shredders, one or more combined shredder/slicers, one or more cubers, one or more dough hooks, one or more whippers, one or more slicers, and one or more french fry cutters. In some cases, a processing tool may be one or more tools that are used to clean the food processor container. As used herein, the term "food" includes any solid or liquid comestible, and any mixture of a solid food and a liquid food.

While blender bases are shown and described herein as being positioned under a container such that the base supports the container, in some embodiments, the base may comprise a drive unit which is configured to mount to the top of a container. In other words, for purposes herein, a blender base is not required to be positionable under a container or to support a container.

Stored Sequences

The inventors have appreciated that conventional food processing sequences do not provide desirable results when used with various foods and food combinations. For example, with fibrous ingredients, solid foods with a low liquid content, and/or larger pieces of solid foods, various conventional processing sequences may result in cavitation. That is, in some cases, with food packed into the container, the blades are rotated, and the blades manage to cut through the food that is within the blade path, but without liquid to move the solid ingredients, minimal further processing occurs. To address this issue, users have typically been instructed to add liquid to the container, and/or a use a pusher to periodically push unprocessed food into the blade path, but each method has its drawbacks.

According to embodiments disclosed herein, certain processing sequences are capable of processing foods without user intervention and without the addition of extra liquids—including foods which typically have been difficult to process without user intervention. By doing so, users may be able to include foods in their recipes which they otherwise might avoid only because of the processing difficulties. With the sequences disclosed herein, users also may be able to include the skins of foods that they previously tended to remove Skins are important when trying to include fiber and nutrients in a final, blended product.

One embodiment of a stored sequence **500** which may be used to blend foods, and especially foods or food combinations which resist processing with a blender, is illustrated in FIG. **5**. This sequence may be used with the personal serving container shown in FIGS. **3** and **4** along with the blades shown in the same figures, though any suitable container and processing tool combination may be used with this sequence.

The sequence **500** of FIG. **5** starts with two repetitions of pulse segments of 1.5 seconds on and two seconds off, followed by a first continuous run segment **501** of twelve seconds. By including short "on" segments with interspersed "off" segments (or pause segments with slow rotations) early in the sequence, initial chopping and/or liquefaction is performed without resulting in cavitation. The process of accelerating the blades can move ingredients within the container,

while the "off" segments allow gravity to move solids and liquids into the blade path such that upon restart, these foods are contacted by the blades. This additional contact not only processes the contacted food, but also uses the contacted food to move other food within the container. Accordingly, the pulse segments at or near the beginning of the sequence begin to liquefy some of the softer foods and move around and chop some of the harder foods. If the blades are simply turned on and run continuously at high speed from the start of the sequence, solid food which starts to fall into the blade path is incrementally contacted by the blades, and the resulting small bits of food are not as good at moving other foods.

The continuous run segment **501** of twelve seconds starts processing the rougher ingredients, and continues processing and liquefying the softer foods to start creating a smooth liquid.

The sequence includes an "off" segment **502** and an immediately subsequent rapid acceleration "on" segment **504** to cause liquids and solids to surge briefly upwardly along an inner side wall of the blender container toward the upper end of the blender container. This portion of the sequence uses the liquefied material in the blender container to recapture ingredients that may be caught on the inner wall of the container or the underside of the container lid so that the ingredients may be returned to the blades or other processing tool. For purposes herein, such action is referred to as a fountain effect sequence. The fountain effect sequence is discussed in more detail further below.

Segment **504** is seven seconds long to continue processing the ingredients for a smooth texture. Any ingredients recaptured by the fountain effect segments are liquefied and processed during segment **504**.

Two more "off" and rapid acceleration "on" segments follow segment **504** to again attempt to recapture any foods that have become stuck on the inner walls or the lid underside. A final segment **506** runs continuously for twelve seconds to achieve a final smoothness and to process any foods recaptured during the final fountain effect segments.

The precise times disclosed in this particular sequence are not necessarily required, and may be varied depending on the motor power, blade speed, type of food(s) to be processed, etc. For example, in some embodiments, the first continuous run segment **501** may be at least five seconds, at least seven seconds, at least ten seconds, at least fifteen seconds, or any other suitable length. The second continuous run segment **504** may be at least five seconds, seven seconds, ten seconds, fifteen seconds, or any other suitable length. In some embodiments, the sequence may end after the second continuous run segment **504**. Where the third continuous run segment **506** is included, it may be at least five seconds, seven seconds, ten seconds, fifteen seconds, or any other suitable length. Additional sequential, short "on" and "off" segments may be included before, between, or after the various continuous run segments in some embodiments.

In some embodiments of blend sequences similar to sequence **500**, the total amount of all "on" time periods may be at least twenty-five seconds, at least twenty-nine seconds, at least thirty-six seconds, or any other suitable length. The total time period of the entire sequence may be no more than fifty seconds in some embodiments, no more than forty-five seconds in some embodiments, or limited to any other suitable time period.

For purposes herein, the term "pause" as part of a sequence of food processing apparatus operation refers both to: a) not activating the drive unit for a period of time, and b) activating the drive unit at a level for a period of time such that if the processing tool were to reach a steady state speed based on the average activation level provided to the drive unit over the period of time, the processing tool would have a speed of 100 rpm or less. For example, a blending sequence which includes a 2.5 second time period during which electricity is not provided to the motor is considered to have a 2.5 second pause segment, even though the processing tool may not immediately stop rotating when the motor is de-energized. As another example, a pause segment may include a motor driven at 300 rpm for three seconds, which, through a transmission, results in a steady state processing tool speed of 60 rpm. Even though the processing tool does not have a speed of 60 rpm from the start of the three second time period, the segment is still considered to be a three second pause. As another example, for two seconds, a motor may be cyclically powered to between two power levels which results in the drive unit and blades rotating from between 10 rpm and 20 rpm, with an average speed of 15 rpm over the two second time period. Such a time period would be considered a pause for purposes herein.

Many of the sequence embodiments described and illustrated herein refer to an "off" time period. An "off" time period, for purposes herein, means a time period during which the drive unit is not activated, though the drive unit may continue to rotate during some or all of the "off" period due to residual momentum. However, anytime that an "off" period is referred to herein, a "pause" segment may be implemented instead. For example, segment **502** of FIG. **5** may be a two second pause instead of a two second "off" segment. As discussed above, a pause segment may include slow rotations of a processing tool, or may include a shut-off of the drive unit (such as a motor).

A sequence **600**, as shown in FIG. **6**, may be similar to sequence **500**, but with a shorter final continuous run segment **602** of seven seconds instead of twelve seconds. A higher blade speed may permit the reduced continuous run time. In some embodiments, sequence **600** may be used with the personal serving container similar to the container shown in FIGS. **3** and **4**, but with blender base **100**. See, for example, FIG. **22**.

Examples of foods where such sequences may be particularly beneficial include celery, cabbage, apples, ice, blueberries, and other fibrous foods and/or foods with skins.

For food combinations which are particularly difficult to blend and/or which contain ice, a sequence **700** with a higher number of pulse segments may be used. Sequence **700** includes a total of four pulse segments that have a 1.5 second "on" time period, and a 2.5 second "off" period. The additional pulse segments, as well as the increased "off" time periods relative to sequences **500** and **600**, provide more chopping and initial liquefaction prior to continuous run segments that are longer than ten seconds. Also included in sequence **700** is a five second "on" segment **702** situated between two sets of pulse segments, which is intended to start crushing ice and/or fibrous components. As with sequences **500** and **600**, the starts and stops help to prevent cavitation, while the continuous runs later in the sequence provide the blending which leads to a smooth consistency of the resulting product.

In some embodiments, the pulse segments include an "on" pulse of two seconds or less, while other embodiments include pulses of 2.5 seconds or less, or three seconds or less. In some embodiments, the pulse segments include an "on" pulse of at least 1 second, other embodiments include "on" pulses of at least 1.5 seconds, and further embodiments include "on" pulses of at least two seconds.

In some embodiments of blend sequences similar to sequence **700**, the total amount of all "on" time periods may

be at least thirty seconds, at least thirty-seven seconds, at least 42.5 seconds, or any other suitable length. The total time period of the entire sequence may be no more than fifty seconds in some embodiments, no more than fifty-five seconds in some embodiments, no more than sixty seconds in some embodiments, no more than sixty-five seconds in some embodiments, or may be limited to any other suitable time period.

A sequence **800**, as shown in FIG. **8** may be similar to sequence **700**, but instead of a final continuous run segment of 16.5 seconds, sequence **800** includes a five second continuous run segment **850**, a 2.5 second "off" segment **852**, an "on" pulse **854** of 1.5 seconds, an "off" segment **856** of 2.5 seconds, and a final, continuous run segment **858** of five seconds. The extra two pauses in sequence **800** as compared to sequence **700** may provide two additional fountain effect sequence to recapture food caught outside of the blended mixture. The slight decrease in the total amount of time of "on" segments may be made possible by running the blades at a higher speed as compared to some embodiments of sequence **700**. In some embodiments, sequence **800** may be used with the personal serving container similar to the container shown in FIGS. **3** and **4**, but with blender base **100**. See, for example, FIG. **24**.

A flowchart **900** in FIG. **9** of a blending sequence includes acts which cause ingredients to surge briefly upwardly along an inner side wall of the blender container toward the upper end of the blender container to recapture ingredients that may be caught on the inner wall of the container or the underside of the container lid. For purposes herein, such action is referred to as a fountain effect sequence.

As one example of a fountain effect sequence, after a series of pulses where the motor is on for an amount of time, and then off (or otherwise paused) for 2.5 seconds, a sustained processing segment **902** runs for twenty seconds. During segment **902**, the rotating processing tool may cause liquid in the container to form an inverted substantially conical shape on its surface due to the rotation of the liquid within the container. That is, the liquid may be slightly higher along the outer edge of the container as compared to the inner portions.

By stopping (or significantly slowing) the rotation of the processing tool in an act **904**, the liquid may settle such that the inverted cone disappears or decreases, and some or all of the solid foods within the liquid mixture may fall toward the bottom of the container. After the liquid has been allowed to calm for a suitable amount of time, for example, 2.5 seconds in some embodiments, the processing tool is accelerated quickly to rapidly jettison liquid outwardly toward the walls of the containers as part of an act **906**. The surge of liquid pushes up the inner walls of the container to reach upper areas that were not being contacted during the sustained processing of act **902**. In this manner, food caught in the upper reaches of the container can be returned to the liquid mixture for proper processing. For example, food caught on the upper side wall, and in some cases the underside of the container lid, may be gathered with this stored sequence.

In the illustrated embodiment, act **906** includes a rapid acceleration, and the motor remains on for a total of 2.5 seconds. In other embodiments, the processing tool may be rapidly accelerated and remain on for only 1.5 seconds, or any other suitable length of time. Or, in some embodiments, the processing tool may be accelerated over a period of approximately three-quarters of a second, and the motor held on for a total of at least four seconds or a significantly longer amount of time.

The rapid acceleration of the processing tool may be approximately at least 2,500 rpm per second within a 72 oz. container holding 64 oz. of liquefied food in some embodiments, and the top speed may be reached within approximately 0.75 seconds of starting the motor. With a 5:1 ratio transmission present, the motor may accelerate at 12,500 rpm per second for the same container to accelerate the processing tool at 2,500 rpm per second. In some embodiments, the speed attained after the rapid acceleration is approximately equal to the speed prior to the slowdown or stop, while in other embodiments, the speed attained after the rapid acceleration may be different from the speed prior to the slowdown or stop.

Other acts of starting the motor within the same sequence may include a "soft start" where the motor is not allowed to accelerate as quickly as it is capable of doing, while the act of rapidly accelerating the processing tool may not include a restriction on the acceleration. In some embodiments, the food processing apparatus may be configured such that the food processing tool achieves an acceleration of at least approximately 3,400 rpm per second with a 72 oz. container holding 64 oz. of liquefied food. In other embodiments the food processing apparatus may be configured to achieve an acceleration of at least approximately 2,000 rpm per second with a 72 oz. container holding 64 oz. of liquefied food. In some embodiments, other acts of starting the motor within the same sequence and/or within other sequences may not include a "soft start".

The sequence that sends liquid up the side wall can be preceded and/or followed by continuous processing acts (e.g., 10 seconds or more, 13 seconds or more, or 20 seconds or more) in some embodiments so that desirable pulverization of the food items is achieved. Additionally, by including a relatively long, continuous processing act prior to a step of propelling liquid up the side wall of the container, there is a high likelihood that the processed ingredients will have been sufficiently liquefied to allow the liquid surge to work. Though the amount of time required to liquefy the food ingredients can be dependent on the type and quantity of food being processed. In some embodiments, a sensor may be used to verify that sufficient liquefaction has been achieved prior to starting a sequence configured to propel liquid up the side wall. In some embodiments, no verification or sensing of the liquid properties of the food ingredients is provided.

During a fountain effect sequence, instead of completely stopping the motor and processing tool, the motor may be significantly slowed. For example, in some embodiments, the motor may be slowed to 10% or less of its prior speed to permit solid contents to settle and/or allow the liquid flow within the container to slow. Or the processing tool may be slowed to approximately 100 rpm or less to allow settling of contents.

According to another aspect, a sequence shown in flow chart **1000** of FIG. **10** is particularly suited to process frozen food items. The sequence includes a series of six pulses where the motor runs for 1.5 seconds and then stops for 2.5 seconds. A twenty second continuous run is followed by a three second pause, and then a 23 second continuous run. The time period where the motor is off for three seconds and then followed by the 23 second run may be a fountain effect sequence in some embodiments by having the motor accelerate quickly at the beginning of the 23 second run. In other embodiments, the overall sequence may not include a fountain effect, and instead may have a slow start to the 23 second run. This frozen item blending sequence may be particularly effective when used in combination with the blade assembly shown in FIGS. **20** and **21**. By incorporating a stopped portion between two extended run periods, larger pieces of food can fall back toward the bottom of the container and/or move toward the

middle of the container, allowing the larger pieces to be chopped or otherwise processed by the blades or other processing tool.

According to another aspect of the disclosure, a specific sequence of blending operations may be instituted to purée foods. For example, in some embodiments, a progression of faster speeds may be used to create a purée. A first and second speed may progress from low to medium to start processing the food, such as chick peas. A third, high speed segment is run after the low and medium segments. By starting at slower speeds, the blades initially break down the ingredients so that during the higher speed phase, cavitation can be avoided. The higher speed purées the ingredients quickly, but starting immediately at high speed could result in cavitation. In some embodiments, the high speed may be run for longer than the low and medium speed times combined, such as shown in the embodiment of FIG. **11**A with a flow chart **1100**. In some cases, the sequence may be arranged so that a given steady-state speed is not slower than any preceding steady-state speed. A purée sequence such as the one shown in FIG. **11**A may be particularly useful in combination with the blade arrangement shown and described with reference to FIG. **3**. In some embodiments, a purée sequence may include no stopping of the motor during the sequence.

As shown in FIG. **11**B with a flow chart **1150**, the apparatus may be operated at a low speed for a longer period of time than a high speed. For example, in the embodiment of FIG. **11**B, the blades are rotated at a first, low speed for fifteen seconds, then at a medium speed for ten seconds, and finally at a high speed for ten seconds. Such an arrangement may be helpful when the high speed segment is run at 1,300 watts or below, in order to sufficiently process the ingredients during the low and medium segments to permit a desirable flow of ingredients during the high speed segment. A purée sequence such as the one shown in FIG. **11**B may be particularly useful in combination with the blade arrangement shown and described with reference to FIG. **3**. In some embodiments, the total time period of a low speed segment and a medium speed segment combined may exceed the time period of a high speed segment. The low speed may be run with a motor power that would provide 15,000 rpm unloaded—900 watts in some embodiments, or at another suitable power. The medium speed may be run with a motor power that would provide 20,000 rpm unloaded—1,200 watts in some embodiments, or at another suitable power. And the high speed may be run with a motor power that would provide 21,500 rpm unloaded—1,275 watts in some embodiments, or at another suitable power.

FIG. **12** shows a flow chart **1200** of a sequence for pureeing food, where a third, high speed is run for longer than a first, low speed and a second, medium speed combined. In this particular embodiment, the low and medium speeds are operated for five seconds each, and the high speed is operated for fifty seconds. One or more of the low, medium, and high speed segments may be run for longer than five seconds, five seconds, and fifty seconds respectively in some embodiments. In some embodiments, the low speed is run for at least four seconds, the medium speed is run for at least four seconds, and the high speed is run for at least forty seconds.

A purée sequence such as the one shown in FIG. **12** may be particularly useful in combination with the stacked blade arrangements shown and described with reference to FIGS. **20** and **21** further below.

FIG. **13** shows a flow chart **1300** of a sequence for pureeing food, where again, a third, high speed is run for longer than a first, low speed and a second, medium speed combined. In this particular embodiment, the low and medium speeds are operated for five seconds each, and the high speed is operated for sixty-five seconds. One or more of the low, medium, and high speed segments may be run for longer than five seconds, five seconds, and sixty-five seconds respectively in some embodiments. In some embodiments, the low speed is run for at least four seconds, the medium speed is run for at least four seconds, and the high speed is run for at least fifty-five seconds.

A purée sequence such as the one shown in FIG. **13** may be particularly useful in combination with the stacked blade arrangements shown and described with reference to FIG. **23** further below.

A sequence configured for use with the blades and container shown in FIG. **3** is shown with a flow chart **1400** in FIG. **14**. This sequence may be used to process frozen foods to produce a personal serving. A series of four pulses start the sequence, each being 1.5 seconds on and 2.5 seconds off. An act of powering the processing tool for twenty-two seconds follows the pulses. The motor is then turned off for 2.5 seconds, and then rapidly accelerated to provide a fountain effect. Once the motor is brought up to speed by the rapid acceleration, the motor is maintained on for a total of 19.5 seconds. The motor may be powered for other periods of time, for example, at least eight seconds in some embodiments.

In some embodiments, the overall sequence may not include a fountain effect sequence, and instead may have slow start to the 19.5 second run. The sequences associated with frozen food, such as the sequence shown in FIG. **14**, may be used with processing assemblies and containers other than those shown in FIG. **3**. The sequence of FIG. **3** (and variants thereof) may be used with the blender base shown in FIG. **2**, or, in some embodiments, may be used with the blender base shown in FIG. **1**. For example, see FIG. **24** which shows a container similar to that of FIG. **3** being used with the blender base of FIG. **1**.

The blades and container shown in FIG. **3** may be used with the sequence shown in flow chart **1500** in FIG. **15** to process fresh foods. The sequence includes two pulses of 1.5 seconds on and two seconds off, followed by a twelve second on period. A fountain effect sequence is then employed, with a two seconds off, followed by a rapid acceleration. In some embodiments, the act of running the motor for twenty-four seconds after the two second pause may not include a rapid acceleration, and may instead include an acceleration where the power to the motor is restricted.

The illustrated sequence may be used with containers and/or processing tools other than the container and processing tool shown in FIG. **3** in some embodiments.

FIG. **16** shows a flow chart **1600** for one embodiment of a sequence that is particularly suited for personal serving containers (e.g., see FIG. **3**) when pureeing food items. The sequence includes fifteen seconds at a low setting, ten seconds at a medium setting, and ten seconds at a high setting. The low setting may be run at a power which runs the motor at approximately 15,000 rpm when unloaded (though more slowly when loaded). The medium setting may be run at a power which runs the motor at approximately 20,000 rpm when unloaded, and the high setting may be run at a power which runs the motor at approximately 21,500 rpm when unloaded.

A seventy second sequence is illustrated in flowchart **1700** in FIG. **17** as one embodiment which is particularly suited to crush ice as part of processing ingredients in personal serving container, such as the container shown in FIG. **3**. This sequence includes two pulses followed by five seconds on and 2.5 seconds off. Two more pulses are executed, followed by twenty seconds on, 2.5 seconds on, and then another pulse.

The sequence concludes with twenty seconds of continuous run time. Each of the segments may be run at 85% power in some embodiments.

User-Alterable Program

A flowchart **1800** of a pulse control algorithm is shown in FIG. **18** as one example of a food processing sequence which can be altered by a user during operation of the sequence. In an act **1802**, the controller checks that a container is engaged with the blender base via a sensor. If engaged, the controller checks whether a pulse switch is closed (i.e., actuated) in an act **1804**. The pulse switch may be closed by a user pressing a button in some embodiments, or in any other suitable manner. The term "switch", for purposes herein, is intended to be construed broadly, in the sense that any device or structure which receives a user input and is capable of communicating the resulting state of the device to the controller should be considered to be a switch.

Once the pulse switch is closed, the motor is turned on for 0.25 seconds in an act **1806** in the illustrated embodiment. The motor is then shut off regardless of any further action taken by the user with respect to the pulse button during the 0.25 seconds that the motor is running After the 0.25 seconds of motor run time, if the pulse switch has been continuously closed (e.g., by the user continuously pressing the pulse button) throughout the 0.25 seconds, as checked in an act **1808**, the motor remains off until one of two actions occurs. In a first scenario, if the pulse button continues to be pressed, that is, if the button is not released from the time of its initial pressing, the motor will re-start 1.5 seconds after the initial 0.25 run time is completed, and run for a second 0.25 second time period (act **1810**). This stored 1.5 second interval represents a default "off" time. In a second scenario, if the pulse button is released at any time, and then re-pressed while the motor is off, a new 0.25 second motor run time is started at the time of the re-pressing of the button. In this manner, in an act **1812**, the motor remains off until the pulse switch is closed.

In this manner, the user is able to control the "off" time during the pulsing routine, but the "on" time is not alterable by the user through use of the pulse button. In some embodiments, pressing an "off" or "stop" button can stop the motor during a pulsing routine prior to the programmed stop time.

If the pulse button is continuously held, the motor will cycle through the stored on and off time periods until a stored number of cycles is reached in some embodiments. For example, in some embodiments, the motor will turn on thirty times, with pauses between the run times, before the controller stops causing the motor to run.

A counter display may be included on the food processing apparatus in some embodiments to indicate to the user how many cycles (i.e., how many motor activations) have occurred. Releasing the pulse button does not reset the counter in some embodiments. For example, if eight cycles have been run, and the user releases the pulse button to extend an off time, the number "8" will remain on the display and resume upward counting if the pulse button is again pressed. If, after the pulse button has been released, the user presses a different sequence button or other button prior to re-pressing the pulse button, the display will stop displaying the number of pulse cycles, and the next time the pulse button is pressed, the display counter will start at zero.

In some embodiments, the amount of time that the motor is on for each pulse may be different than 0.25 seconds. For example, in some embodiments, it may be 0.20 seconds, or 0.50 seconds, or any other suitable length of time. The default time may be different than 1.5 seconds. In some embodiments, the default time may be 1.0 seconds or 2.0 seconds, or any other suitable length of time.

The lengths of times (e.g., 0.25 seconds "on" and 1.5 seconds "off") may be based on values stored in a memory associated with the controller. For purposes herein, when a stored value is used twice—once in a first instance and once in a second instance, the stored value may be considered to be two values. For example, consider a configuration where a first time period is described as being based on a first stored value, a second time period is described as being based on a second stored value, and both time periods are the same length of time. Even if the exact same stored value is referenced by the controller to set the length of both time periods, for purposes herein, one may consider that two stored values exist.

In some embodiments, the user may alter the amount of time that a certain segment of an overall sequence lasts, and the user may make this alteration during the operation of the sequence, or even during the operation of the particular segment being altered. For example, the length of a high speed segment may be extended by the user by pressing a "continue" or "extend" button (or other suitable input) while the high speed segment is operating. This segment may be a portion of the sequence that is not at the end of the sequence in some embodiments.

Dual Coupler

FIG. **19** is a top view of base **100** for a food processing apparatus according to one embodiment of the present disclosure. The base **100** includes a body having a first, inner drive coupler **1902** and a second, outer drive coupler **1904**. The drive couplers **1902**, **1904** can be driven by the motor (not shown) within the base **100**. A transmission system may be configured within the base **100** to rotate the first, inner drive coupler at a faster speed than the second, outer drive coupler **1904**. A first container used with the blender base **100** may couple with only the first, inner drive coupler **1902**. For example, a personal serving type of container as shown in FIG. **3** may couple with the inner driver coupler **1902**. A second container, e.g., the container **2202** shown in FIG. **22** or the container **2102** shown in FIG. **23**, may couple with only the second, outer drive coupler **1904**. In this manner, processing tools can be driven at different speeds by a motor operating at a single speed.

The first row of Table 1 below shows the rotational speeds at which the motor would operate for the low, medium, high, and pulse settings in some embodiments. Rows 2-4 show the rotational speeds of the processing tools in the identified container (again assuming that no food is present in the container). The reduced speeds of the processing tool in the 72 oz. jar are a result of the outer drive coupler being geared down by a 5:1 ratio (see FIG. **19** and its associated description). The 7-up bowl container also couples with the outer drive coupler, and additionally includes a 3:1 gear down within the container itself, resulting in an overall 15:1 gear down relative to the motor speed.

TABLE 1

| | Low | Medium | High | Pulse |
|---|---|---|---|---|
| Motor | 15,000 rpm | 20,000 rpm | 24,000 rpm | 24,000 rpm |
| 72 oz. Container | 3,000 rpm | 4,000 rpm | 4,800 rpm | 4,800 rpm |
| 7-Cup Bowl | 1,000 rpm | 1,333 rpm | 1,600 rpm | 1,600 rpm |
| Bowl in Bowl | 1,000 rpm | 1,333 rpm | 1,600 rpm | 1,600 rpm |

Table 2 shows the rotational speed of the processing tool (e.g., blades) in the personal serving container. There is no gearing down of the motor speed to the blade speed in some embodiments, and therefore the motor speed is the same as the blade

speed. The power supplied to the motor at the high setting may be 85% of rated power, thereby keeping the motor speed and blade speed to approximately 21,500 rpm.

TABLE 2

| | Low | Medium | High | Pulse |
|---|---|---|---|---|
| Personal Serving Container | 15,000 rpm | 20,000 rpm | 21,500 rpm | 21,500 rpm |

Container Sensors

Also visible on the blender base **100** illustrated in FIG. **19** are three depressible plungers **802***a*, **802***b*, and **802***c*, some or all of which may be used to sense the presence of a container on the blender base by being pressed by protrusions on the containers such that the plungers trip a switch. In some embodiments, the plungers, or other sensors, may be used to determine what type of container is mounted to the blender base.

For example, in one embodiment, one of plungers **802***a* and **802***b* is configured to be pressed by a protrusion on a 72 oz. container, such as the one shown in FIG. **22**, when the container is attached to the blender base **100**. Which of the two plungers **802***a*, **802***b* is pressed when the container is attached depends on the orientation of the container when it is attached. In either of the two available orientations, either plunger **802***a* or plunger **802***b* is pressed. A plunger **802***c* is not pressed when the 72 oz. container is attached to the blender base. In this embodiment, the controller may be configured to determine that the 72 oz. container is attached when either of plungers **802***a* or **802***b* is pressed but plunger **802***c* is not pressed.

When a food processing container, such as the one shown in FIG. **23**, is mounted to blender base **100**, plunger **802***c* is pressed. One or both of plungers **802***a* and **802***b* may additionally be pressed, but the controller may be arranged to determine that the food processing container is attached when plunger **802***c* is pressed.

To sense the presence of a personal serving container, a separate sensor, such as one or more depressible protrusions arranged to interact with tabs of the personal serving container may be used. When a switch associated with the depressible protrusion is triggered, the controller may determine that the personal serving container is attached.

Depending on which type of container is sensed to be present on the blender base, one or more of the buttons may not be available for used as a user input. For example, referring back to FIG. **1**, button **118** may only be useable when the personal serving container is mounted to the blender base. When the personal serving container is mounted to the base, an indicator light **132** illuminates to let the user know that the sequence associated by button **118** is available for use with the mounted container. When a different type of container is mounted to blender base **100**, indicator light **132** does not illuminate, thereby indicating to the user that that particular sequences is not available for use.

In some embodiments, the same button may be used to initiate different sequences depending on which type of container is attached. For example, pressing button **116** may cause a purée sequence to start. However, when a container of the type shown in FIG. **22** is present, the purée sequence initiated by pressing button **116** may be the sequence illustrated in FIG. **12**, while the sequence illustrated in FIG. **13** may be initiated when a container of the type shown in FIG. **23** is mounted to blender base **100**. In this manner, the food processing apparatus may permit one touch operation in conjunction with selective use of two or more containers. In other embodiments, a user may press a separate start (button to initiate operation) after pressing a button which selects a certain sequence.

Blade Embodiments

FIGS. **20** and **21** illustrate one embodiment of a blade assembly **2000**. As shown, the blade assembly **0200** has a shaft **2004** and a plurality of blades **2006**, and the blades **1806** are arranged in sets of blades which are spaced apart along the length of the shaft **2004**. In one illustrative embodiment, the blade assembly includes three sets of blades **2006**, but it should be recognized that in another embodiment, the blade assembly may include a different number of sets of blades, for example one set, two sets, or four or more sets. In some embodiments, instead of sets of two blades, sets of blades with different numbers of blades (e.g., three or four blades per set) may be used. The blades **2006** may be removably attached to the shaft **2004** or permanently attached to the shaft **2004**. For purposes herein, a set of blades is intended to mean two or more blades which are associated with each other in a manner other than being attached to the same shaft. For example, a set of blades may include two blades which have been cut from the same blank and attached to the shaft such that the two blades are made from a single piece of material and remain connect around the outside of the shaft. Or, in another example, a set of blades may include three blades which extend radially outwardly from the shaft in the different directions, but each at approximately the same vertical location on the shaft. In another example, a set of blades may include two blades extending radially outwardly from the shaft in the same direction, but spaced vertically from one another without any other blades between the two blades. In yet another example, a set of blades may include two blades which extend outwardly from the shaft in opposite directions and located more closely with each other than with another blade on the shaft.

A first end **2002** of the blade assembly **2000** is configured to engage with the lid. More specifically, as shown, the first end **2002** of the blade assembly may include a pin or other protruding component configured to be inserted into a bushing (not shown) located on an underside of a container lid (see FIG. **22**). It should be appreciated that the invention is not limited in this respect, and for example, in another embodiment, the first end **2002** of the blade assembly **2000** may include a recess component engageable with a protruding component on the lid, and/or the second end **2008** of the blade assembly **2000** may include a protruding component that is engageable with a recessed component on the container.

As shown in FIG. **21**, a second end **2008** of the blade assembly may be configured to engage with a container. In this particular embodiment, the second end **2008** of the blade assembly includes a cavity that is configured to engage with a spindle (not shown) in the container. As shown, the second end **2008** of the blade assembly **2000** may include a pattern, such as a star-shaped pattern which engages with the shape of the spindle. Although a star-shaped pattern is illustrated, other configurations are also contemplated, such as, but not limited to, circular, triangular, square, rectangular, or hexagonal patterns.

It should be recognized that the blade assembly **2000** shown in FIGS. **20** and **21** may be used for various applications, such as, but not limited to cutting, slicing, dicing, and pureeing food within the container. In the illustrated embodiment, the blades **2006** have sharp leading edges which are rearwardly curved relative to the direction of rotation.

Container Embodiments

A 72 oz. container **2202** with an attached lid **2204** is shown mounted to blender base **100** in FIG. **22**. A blade assembly **2000** similar to the blade assembly illustrated in FIGS. **20** and **21** is positioned within the container. Other sizes of containers may be used in various embodiments. Other blade arrangements or other processing tools may be used with containers that are mounted to blender base **100**. In some embodiments, blade assemblies which include transmissions positioned within the container itself may be used in conjunction with blender base **100** and stored sequences that are used to operate the food processing apparatus.

FIG. **23** shows one illustrative embodiment of a food processing container **2302** which has blade assembly **2304** with two pairs of blades **2306**, **2308**. The food processing container may have a volume of approximately 56 oz. in some embodiments, though any suitable size may be used. A lid **2310**, which may be lockable to the container in some embodiments, is also provided. As mentioned above, a transmission (not shown), such as a planetary gear assembly, may positioned underneath the container such that driving a driven coupler results in a slower rotational speed, but higher torque, of the processing tool as compared to the drive coupler,

FIG. **24** shows one embodiment of a personal serving container **2402** mounted to blender base **100**. The container and blade assembly may be similar to the container and blade assembly shown in FIG. **3**. In some embodiments, personal serving container **2402** may have a volume of 18 oz., while other embodiments may include a personal serving container with a volume of 24 oz. or 32 oz.

Controller

FIG. **25** is a block diagram of an illustrative embodiment of a computer system **2500** that may be used in one or more of the food processing apparatuses disclosed herein, or used to perform one or more of the methods described herein, e.g., as a controller. Computer system **2500** may include one or more processors **2510** and one or more non-transitory computer-readable storage media (e.g., memory **2520** and/or one or more storage media **2530**). The processor **2510** may control writing data to and reading data from the memory **2520** and the non-volatile storage device **2530** in any suitable manner, as the aspects of the invention described herein are not limited in this respect. The computer system **2500** also may include a volatile storage media.

To perform functionality and/or methods described herein, the processor **2510** may execute one or more instructions stored in one or more computer-readable storage media (e.g., the memory **2520**, storage media, etc.), which may serve as non-transitory computer-readable storage media storing instructions for execution by the processor **2510**. Computer system **2500** also may include any other processor, controller or control unit needed to route data, perform computations, perform I/O functionality, etc. For example, computer system **2500** may include any number and type of input functionality to receive data and/or may include any number and type of output functionality to provide data and/or audio and/or visual feedback to a user, and may include control apparatus to operate any present I/O functionality.

In connection with the food processing sequences and other food processing control described herein, one or more programs configured to receive user input(s), receive signals from one or more sensors, evaluate inputs, set run times and/or run speeds, and/or provide feedback and/or information to user may be stored on one or more computer-readable storage media of computer system **2500**. Processor **2510** may execute any one or combination of such programs that are available to the processor by being stored locally on computer system **2500** or accessible over a network. Any other software, programs or instructions described herein may also be stored and executed by computer system **2500**. Computer **2500** may be a standalone computer, server, part of a distributed computing system, mobile device, etc., and may be connected to a network and capable of accessing resources over the network and/or communicate with one or more other computers connected to the network.

Implementation of some of the techniques described herein using a computer system (such as computer **2500**) is an integral component of practicing these techniques, as aspects of these techniques cannot be realized absent computer implementation. At least part of the inventors' insight is derived from the recognition that control of food processors in certain manners described herein can only be implemented using a computer system.

The terms "program" or "software" are used herein in a generic sense to refer to any type of computer code or set of processor-executable instructions that can be employed to program a computer or other processor to implement various aspects of embodiments as discussed above. Additionally, it should be appreciated that according to one aspect, one or more computer programs which, when executed perform methods of the disclosure provided herein, need not reside on a single computer or processor, but may be distributed in a modular fashion among different computers or processors to implement various aspects of the technology described herein.

Processor-executable instructions may be in many forms, such as program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. Typically, the functionality of the program modules may be combined or distributed as desired in various embodiments. Also, data structures may be stored in one or more non-transitory computer-readable storage media in any suitable form.

According to some embodiments, a user interface and/or controller may be partially or completely present on a wireless device which is physically separate from the food processing apparatus, yet be considered as being a component of the apparatus. In some embodiments, all or a portion of the user interface may utilize a touchscreen interface or soft keys. Other examples of inputs for user interfaces include dials, switches, rotary knobs, slide knobs, voice-activated commands, virtual keyboards, or any other suitable input.

As used herein, the terms "connected," "attached," or "coupled" are not limited to a direct connection, attachment, or coupling, as two components may be connected, attached, or coupled to one another via intermediate components.

The above described components may be made with various materials, as the invention is not necessarily so limited.

The above aspects may be employed in any suitable combination, as the present invention is not limited in this respect. Additionally, any or all of the above aspects may be employed in a food processing apparatus; however, the present invention is not limited in this respect, as the above aspects may be employed to process materials other than food.

Having thus described several aspects of at least one embodiment of this invention, it is to be appreciated that various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be part of this disclosure, and are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description and drawings are by way of example only.

What is claimed is:

1. A food processing apparatus comprising:
a drive unit to drive a food processing tool;
a controller to control the drive unit; and
at least one non-transitory memory storing:
first, second, third, and fourth values; and
processor-executable instructions that, when executed by the controller, cause the controller to:
in response to a first user input, activate the drive unit for a first amount of time, the first amount of time based on the first value;
discontinue activation of the drive unit after the first amount of time elapses;
based on the second value, set a default restart time at which to restart activation of the drive unit;
wherein when a second user input is not received before the default restart time, activate the drive unit for a second amount of time starting at the default restart time, the second amount of time based on the third value; and
wherein when a second user input is received after the first user input and before the default restart time, set a restart time for earlier than the default restart time, and activate the drive unit for a third amount of time starting at the restart time, the third amount of time based on the fourth value.

2. A food processing apparatus as in claim 1, wherein the first user input comprises a switch initially actuated by a user, and the first amount of time remains the same regardless of whether, after the initial actuation, the switch is de-actuated by the user, continuously actuated by the user, or re-actuated by the user.

3. A food processing apparatus as in claim 1, wherein the first user input comprises a switch being continuously actuated by a user from an initial actuation until at least the start of the third amount of time.

4. A food processing apparatus as in claim 1, wherein the third and fourth values are the same value.

5. A food processing apparatus as in claim 1, further comprising a container and the food processing tool.

6. A food processing apparatus as in claim 1, wherein a same button is used for both the first user input and the second user input.

7. A food processing apparatus as in claim 1, wherein when a second user input is received before the default start time, the default start time is set to be a time at which the user second user input is received.

8. A food processing apparatus as in claim 1, wherein the second amount of time is not equal to the third amount of time.

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